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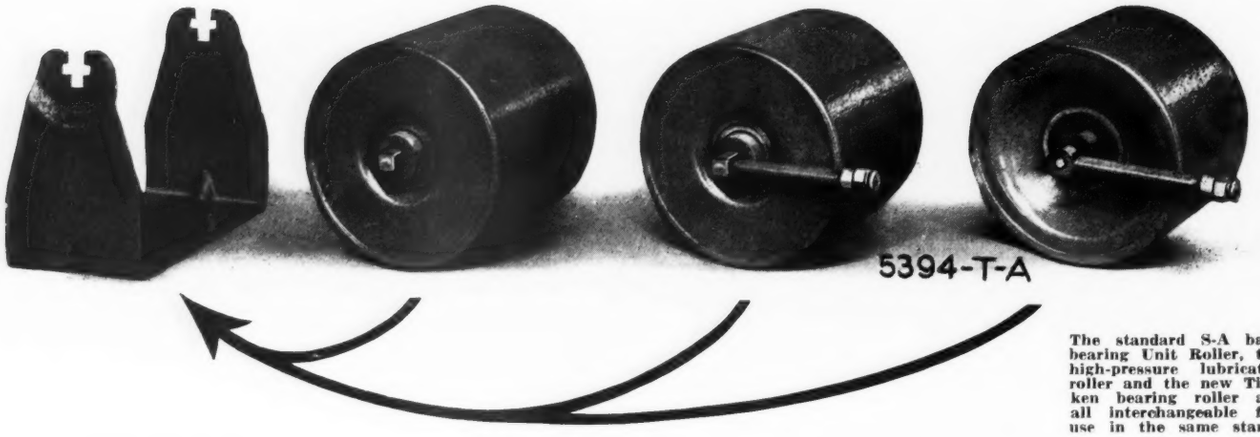

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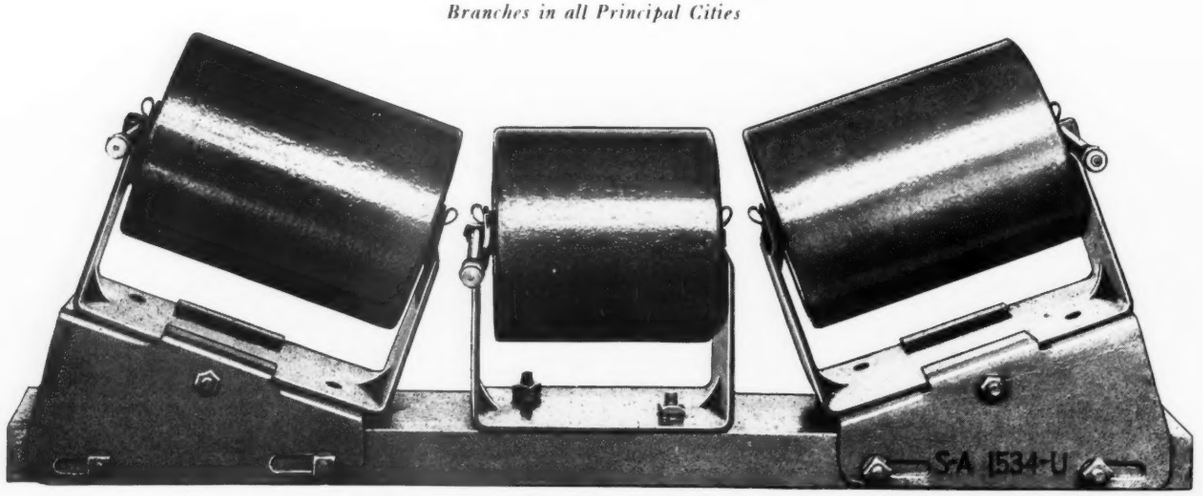

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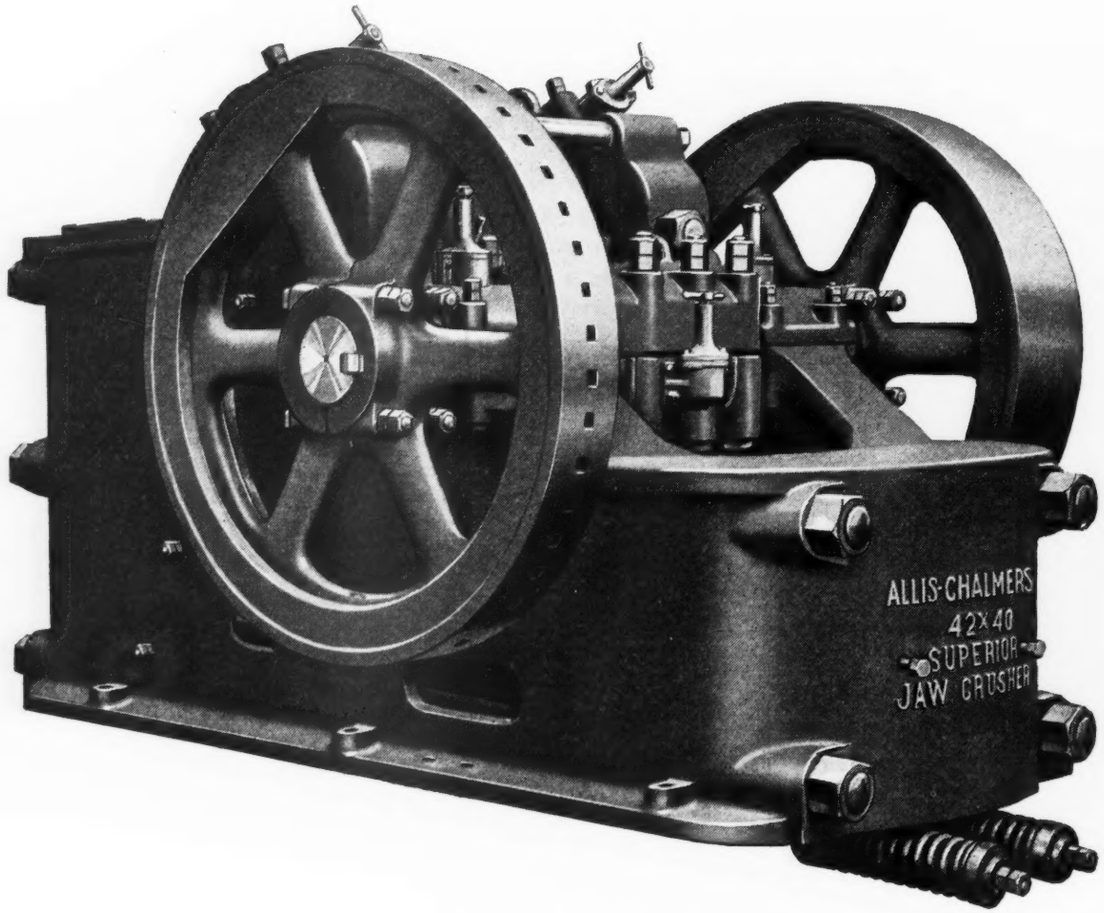

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ENGINEERING AND
MINING JOURNAL

JOSIAH EDWARD SPURR, Editor

Volume 123 New York, April 2, 1927 *Number* 14

The Lead-Zinc Zone at Sudbury

THE REPORTS of considerable lead-zinc deposits discovered by drilling in the region of Chelmsford, in Ontario, in the vicinity of the Sudbury nickel district—drilling conducted by the Bunker Hill & Sullivan company—are of great interest. These newly discovered deposits bid fair to expand the mineral output of Ontario: they moreover serve to illustrate modern conceptions of ore deposits.

The region around Chelmsford is in the center of the elongated synclinal trough of pre-Cambrian sediments which is rimmed by the well-known zone of norite-micro-pegmatite in whose vicinity occur the great nickel deposits which make Sudbury the chief nickel-producing center of the world, yielding as it does 85 to 90 per cent of the world's nickel. With the nickel is much copper, produced separately or as Monel metal. The copper is a later crystallization than the nickel, upholding the succession of metals from basic magmas as proposed by the Zonal Theory.

In some of the nickel mines there is also a marked amount of lead and zinc. At the Worthington mine, for example, the magmatic succession, as determined by Knight, was: 1, norite; 2, nickel-copper sulphides; 3, trap; 4, diabase; 5, sulphides (lead-zinc). This lead-zinc, a later crystallization than the nickel-copper sulphides, represents a cooler zone, which, with the sinking of the isogeotherms during the period of ore injection, migrated downward till it was superimposed on the zone in which the nickel-copper sulphides were earlier deposited: and consequently all occur in one mine, though in distinct veins. But while the nickel-copper was being deposited, then at the same time, in an upper zone, the lead-zinc ores were inferentially being deposited, and in larger measure than those later ores of lead and zinc which were deposited after the isogeotherms had migrated downward.

The mineral map of the Sudbury district has long indicated the location of the ores of the upper zone; the occurrence of lead and zinc ores has been shown in the center of the spoon-shaped depression. Now drilling in this area indicates the lead-zinc sulphides—with some copper—as occurring in large masses. The enormous deposition of nickel and copper sulphides in the geologically lower zone of mineralization makes it not unexpected that the lead-zinc deposits of the geologically upper zone should also be on a large scale: and from this theoretical viewpoint the prospect is most encouraging.

Plan for Resumption of Hydraulic Mining in California

A PLAN for the resumption of hydraulic mining in California has been put forth by a special commission and submitted to the present legislature of that state. It provides for initiating operations upon the Bear, American, and Yuba rivers, upon the watersheds of which auriferous gravels are present in both quantity and value sufficient to warrant the assumption that there is strong probability of successful operation over a period of years. It is proposed to erect three dams and to purchase débris storage in a fourth. To effect the latter it will be necessary to amend the California Débris Act of 1893. As that act also provided for a charge of 3 per cent of the gross output of hydraulic mines as payment for débris storage, it will be necessary to change this to a charge based upon part or all of the cost of storage. The amendment and changes suggested have for their purpose a more workable law, and are not only fair to the miner but are necessary as well.

The cost of erecting the three dams and purchasing storage is estimated to be $2,405,000. Of this sum $1,500,000 is the price at which 350,000,000 cu.yd. of storage space is offered to the commission by the Yuba River Power Co., which is planning to construct a dam at the Narrows, near Smartsville, on the main Yuba River. The remainder, $905,000, is the estimated cost for constructing three dams. Both the federal and state governments are to be asked to carry the burden of financing on a share and share alike basis, construction and administration to be under the direction of the California Débris Commission. The payments by hydraulic mining operators are expected to provide a revolving fund for the construction of additional dams in other places. A bill has been introduced into the present legislature proposing to appropriate $300,000 for the thorough investigation of dam sites and purchase of necessary lands.

The engineer of the Hydraulic Mining Commission, Arthur Jarman, estimates that about 400,000,000 cu.yd. of storage capacity can be obtained for the estimated cost of $2,405,000, or an average cost of slightly more than 0.5c. per cubic yard, without, however, including interest charges. Based upon the amount of available water upon the watersheds in question, Mr. Jarman estimates that approximately 10,000,000 cu.yd. of gravel could be mined annually, yielding $1,156,000. Storage capacity is estimated to be sufficient for twenty years' operation, with an additional storage capacity of twenty years more at the Narrows dam. The controlling factor affecting the rate of working is available water.

The tentative proposals appear to be practicable and to indicate that the cost of storage, although high in some instances, is, viewed broadly, probably within the miners' ability to pay. They have the merit of being conservative and offering possibilities for the partial resumption of hydraulic mining. This resumption is greatly to be desired, and those who have the mining interests at heart should lend their efforts toward bringing it about. Both business men and agriculturists (for the latter will be benefited by increased water storage) should get together with the miners and by earnest co-operation work out a practical basis for new business in mining. The hydraulic miner will not have

an easy time, for modern conditions are unlike those of the eighties. However, he will have some advantages not possessed by the old-time miner. In addition, there is an opportunity for statesmen in the California and national legislatures to play a constructive part in the rehabilitation of this once prosperous mining industry.

What is needed now is the full realization of the Caminetti Act, subject to certain necessary changes already indicated. This act provides that débris storage dams shall be built by the California Débris Commission when appropriations are made therefor by law, but apart from the erection of certain barriers on the Yuba no construction has been undertaken. Hydraulic miners have constructed their own dams in certain instances, but this permissive feature has not proved to be entirely satisfactory and, at any rate, has not resulted in more than a small amount of hydraulic mining. To stimulate an additional amount it will be necessary to finance dam construction at public expense or else to purchase storage capacity created by private enterprise where power development is the important initial objective.

Dowsing Rod or Doodle Bug

WHILE the Continent of Europe, and North America are testing out electrical and other physical devices for the detection of ores underground, using known and calculable principles, there remain, we learn with astonishment, mining regions where the divining rod, actuated by nothing more tangible than personal occult power, is still regarded gravely and with respect by engineers and men of affairs.

A friend sends in the *Cornish Post and Mining News and Redruth Advertiser* (only one journal, not three) for Jan. 22, 1927, containing the account of a meeting of the Cornish Institute of Mining Engineers at the Camborne School of Mines. The paper of the evening was one by Messrs. Gill-Jenkins and Davison, dealing with the driving of the North Cliff Tunnel, including the geology. "Mr. Gill-Jenkins dealt in a lucid manner with the driving of the tunnel, lodes encountered, survey work, a problem in light and dowsing."

"Dowsing," it may be necessary for some to learn, is the process or practice of using the old-fashioned divining rod.

After discussing the engineering and geological features of the tunnel-driving, Mr. Gill-Jenkins proceeded with "dowsing" tests. "During November it occurred to him that the tunnel afforded a unique opportunity of testing the professed art of 'dowsing,' and it was arranged to carry out the experiment. Mr. T. Fiddick, a well-known local exponent, went over the alignment in January, when the south tunnel was in 900 ft., and the north 770 ft., out of 3,031 ft. Mr. Fiddick, who was using the ordinary hazel twig, started from a point well north of the north end and proceeded carefully along the surface alignment to a point somewhat south of the end of the south tunnel, covering a distance of about 1,500 ft. In this distance six lodes were located, and as each lode was found it was marked by a stake driven well into the ground and was verified by proceeding a few yards in the opposite direction. No. 4 lode gave indications of being a strong and important lode, and special attention was paid to it. From the north the influence on the twig commenced at 16 ft. from the stake, and from the south at 10 ft., which seemed to indicate a northerly underlie, and by crossing its course at two or three different points its bearing was obtained which a compass showed to be northeast and southwest. Mr. Fiddick then produced his famous cone—an invention of his own—to experiment on the metallic contents of the lode. The cone swung freely along the bearing of the lode, but when a strip of tin metal was inserted into the cone all movement stopped. This was said to indicate the lode carried tin, and a similar behavior was observed with a copper strip, but a lead one had no effect. Further experiments were made with sheets of colored glass which were placed on the ground beneath the cone as it was swinging. A green glass stopped all movement, and a piece of pitchblende had the same effect, but a blue glass showed no influence." It would have been interesting had a second "dowser" gone over the same ground to see how the lode positions tallied, and in case of a difference, to note how they conformed to the lodes subsequently intersected by the tunnel.

No. 4 point, where a strong lode was located showing a northerly underlie with indications of the presence of both tin and copper ore, did not seem to conform to any of the main lodes intersected by the tunnel, and one would like to see a pit dug there to investigate the matter further. This would be of interest to the mineral owners and to the partisans of "dowsing" and would throw further light on the reliability or otherwise of the professed art. As "dowsing" was of general interest to mining men and diverse opinions were held regarding it, this experiment had been described as fully as possible and "it was left to the reader, after examining the cross-section which accompanies the paper, whether or not a case had been made out in its favor."

Mr. Davison, after discussing the geology of the tunnel, "produced a book issued by the United States Geological Survey in 1917, which set out the purposes to which the dowsing rod had been put. These included the detection of water, mineral bodies, and criminals. [Laughter.]"

Mr. William Hosking observed of the area cut by the tunnel that, "The opinion had been freely expressed that the area through which the tunnel went would undoubtedly, if it were mined, prospected or dowsed, reveal the presence of mineral."

Of these three methods of determining the presence of minerals, we suggest mining.

"Mr. Joseph Blight (joint secretary), proposed thanks to Messrs. Gill-Jenkins and Davison and referred to the art of dowsing. If the points given by Mr. Fiddick did not exactly coincide with the lodes, this might be accounted for by the fact that the lodes were near each other, and if there were a close circuit, the magnetism of the lodes would not give the same attraction to the magnetism of the human body."

A most interesting conclave, surely: but one is impelled to cite the last clause of Captain William Thomas' remarks, when he said, "I am not prepared to say I do not believe in dowsing, but at the same time I cannot dowse."

Unsubstantiated belief in the occult is more a thing of the past than the present, though it persists yet in many corners of the world; but one is hardly prepared to find it seriously treated by the Cornish Institute of Mining Engineers.

An Offering From Germany

ACQUISITION by the Anaconda-Harriman interests of the Giesche Erben property has doubtless turned toward America the eyes of sundry owners and agents of zinc-lead properties on the Continent that are for sale or lease. Perhaps it is responsible for the recent offer from Düsseldorf to a Toronto interest of (quoting the letter) "a lead-zinc mine corporation situated on advantageous place of Western Germany, with more than 81,000,000 sq.ft. mine fields." Continuing, the offer states:

"This object guarantees a conceivably surest basement for a best investment of capital. The metal mining on the worked mine can in a few time be rationally turned and guarantees by laying on of modernest handling-plants a rich revenue source.

"The hitherto examinations of the large mine fields have confirmed the particularly favorable opinions of divers competentors."

The letter is merely a feeler. Anyone interested will be rewarded with further particulars. But in view of the widespread practice of putting the best strawberries on top of the basket, one wonders whether the best that can be said of the property is that it has an area of 81,000,000 sq.ft.

Heavenly Advertising Spreads

NEWS comes from Germany that one of that country's famous optical firms has perfected a giant magic lantern by which printed matter and pictures may be thrown against the dark background of the sky at night by a powerful searchlight. Dense, low-hanging clouds are said to offer the best background. Celestial advertisements are expected soon to be a part of Berlin's night life. Residents of metropolitan New York and London, and perhaps other cities, are already familiar with another form of ethereal publicity, in the sky-writing accomplished by dense smoke emitted by a maneuvering airplane, but the disadvantage of this is that by the time the "Strike" is completed the wind has usually blown most of the "Lucky" away, so that the sky is not disfigured for very long at a time. But when one throws a lantern slide against a cloud, it stays there as long as the advertiser is willing to pay for the service, or until Providence sees fit to send the fog, the rain, or the snow, through which, presumably the light could not penetrate.

Fortunately, the beautiful daytime skies and clouds are otherwise so far exempt, though even they may come to serve the interests of Publicity. One can still look up from the obnoxious signboards that disfigure so much of the city and countryside in this "land of the free," and observe the unspoiled majesty of the heavens. And the crews of submarines report the waters of the earth so far unexploited, though one can never tell what the enterprising manufacturer of fish food may accomplish when the piscatorial language is mastered.

Our mines, too, seem to have been overlooked, for we never remember seeing an advertisement below the shaft collar. Here, perhaps, lies a real opportunity; a colorful ad on the walls of a main level station where visitors are fairly frequent would no doubt attract a lot of attention. "Ajax Dynamite—Not a Headache in a Case of It," or something of that sort. But let us reserve the working faces strictly for mining.

Diamond Drilling

THE DIAMOND DRILL is increasingly an important device for exploration, for delineation of certain types of mineral deposits, and for the confirmation of geological structure as deduced by geological studies. It is an efficient method for boring holes in firm rocks, and by means of it holes of great depth have been drilled. Its analogue, the rotary oil-well drill, has by reason of necessity, mechanical improvements, and the results obtained become the most important oil-well drilling appliance. Nevertheless, the petroleum miner finds that the latter tool does not completely overcome some conditions, and has therefore played with the diamond drill sufficiently to recognize its valuable characteristics.

More and more use is being made of the diamond drill, so much so that now technical articles about it in relation to its use in the petroleum industry are beginning to appear. A bulletin by Frank A. Edson, of the U. S. Bureau of Mines, on the subject was only recently published. In it, Mr. Edson points out that in exploratory or wildcat work, the diamond drill is superior to either rotary or cable drill, by reason of the greater economy and completeness of the information obtained about underground conditions. Nor are drilling costs much greater. In proved oil fields, Mr. Edson expresses the opinion that diamond drilling may ultimately prove to be cheaper than cable-tool drilling, because in some formations it can drill faster, it does not require as many strings of casings, and its cutting efficiency is not affected by great depth.

Undoubtedly, as greater experience is obtained in the use of the diamond drill in oil-producing formations and as modifications in mechanical design are made, the utility of this appliance will become more apparent and its use more widespread. There appears to be an opportunity for developing a new diamond-drilling technique.

No Weeping in Weepah

STORIES OF WONDERFUL FINDS in Canada have become commonplace, even if not tiresome, so it is a relief to see good old Nevada once more mentioned in the headlines as a prospector's paradise. The Tonopah date line has become all too infrequent in the Associated Press dispatches since the Divide boom subsided, but now we are treated to some of the old excitement, and here's hoping it will last beyond the preliminary assay stage!

Early reports indicate that all the old accompaniments of the frontier mining town are beginning to flower: dance halls, gambling dens, blind tigers, and similar aids to human relaxation, all no doubt housed in tents. Only the method of approach is different—the motor car has supplanted the pack horse, mule, or burro.

Weepah, scene of the strike, is forty miles or so from Tonopah, and is a not totally unknown place, even though not specifically mentioned in the gazetteer or in the list of United States post offices. Few now can tell whether it is in the vicinity of Paradise Peak or off Thirsty Canon way, but if there is much more $78,000 ore there, we shall soon know all about it.

Comes, also, Arizona, which offers Dripping Springs, in Gila County, where according to a news dispatch, Jim Girard and Dan McGraw have uncovered a vein a 6-lb. sample from which assayed, 'tis said, $100,000 per ton! But—"little or no work has been done"!

Novel Open-Pit Electric Haulage on Michigan Iron Range

By Edgar Gealy
Assistant Editor

GREATLY REDUCED open-pit mining costs have been made possible recently by the development and successful application of electrically operated and controlled haulage systems now coming into wide use. The new type of equipment enables a single workman, directing operations from a tower, to control the movement of cars to and from the loading shovels and the dumping point.

Fig. 1—One man regulates the movement of individual cars by means of control equipment located in a tower along the haulage system

The equipment comprises a number of separately motored dump cars, which take energy from a third-rail system receiving power which is controlled and regulated by the man in the tower, which is so placed that he can actually see the position of each car or have a definite knowledge of its location by means of indicating lights.

Motors and contactors mounted on each car make it possible for the tower operator to start, stop, or regulate the direction and speed of each car. Suitable control is also provided in the tower, so that distant switches, also electrically operated, can be thrown to direct the moving car or cars to points wherever they are desired. The operator thus causes all the cars on the system to start, stop, reverse, or be switched as occasion demands.

The cars operate over level tracks or up and down grades without anyone riding on them. In normal service empty cars approach the loading shovel singly and are spotted under the dipper by one of the shovel crew, who operates a controller conveniently placed on the shovel for this purpose. When the car is loaded it is started on its way to the dumps by this same shovel controller, and an empty car is run in and spotted within a few seconds. Thus continuous shovel operation is assured without undue capital investment in cars or other haulage equipment.

The apparatus in the tower is usually arranged on two floors. The operator is on the upper floor with the controllers and other devices that he manipulates. Thus he has a clear view of the whole track system. The space on the lower floor is occupied principally by the other automatic parts of the mechanism necessary to handle the various car movements.

In many instances automatic control features are provided for handling the cars at the crushing plant. A car can be run to the dumps and unloaded as slowly or rapidly as required, thus feeding the crusher at the most desired rate and eliminating the crusher attendant and other labor ordinarily required at the dumps or on the cars. Single cars which approach the crusher at intervals can be so regulated as to give a uniform rate of feed.

Each car is an individually powered unit with motors and control apparatus which cause it to function exactly as desired by the towerman. It waits at the loading point only during the period required to fill it, and is then on its way at a speed of from 12 to 20 miles per hour. Likewise at the discharge end of the system it waits only long enough to be discharged. It is therefore seen that the maximum possible quantity of material is carried by the cars used. There are no idle cars, as in the case of train haulage. A minimum amount of car equipment is therefore needed and the length of track required is no greater than needed for haulage purposes. There are no unusually long side tracks or switch spurs.

When the fact is noted that it is possible for a loaded

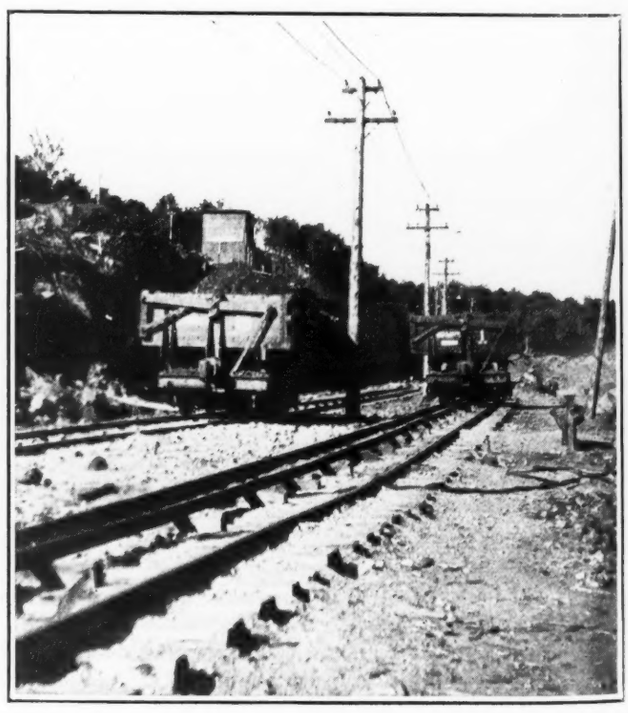


Fig. 2—Each car is provided with its own motor and travels at a rate of speed determined by the towerman

Fig. 3—At the loading point cars can be quickly spotted, loaded, and started to the dump without anyone riding them.

car to travel half a mile while another is being loaded, the advantage of this haulage system is apparent. Usually in other haulage systems much working time is lost when as many as five or six loaded or empty cars must be kept standing idle while one is being loaded.

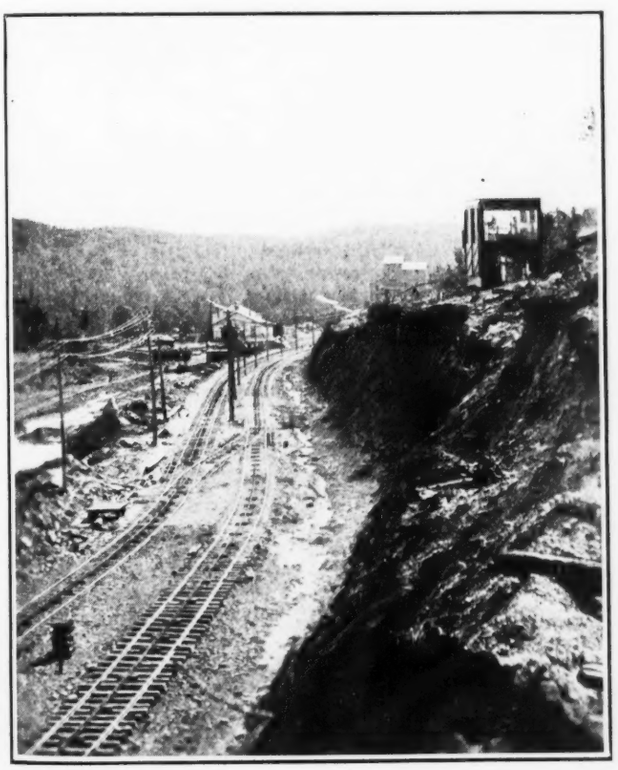


Fig. 4—Because the loaded material is carried over the driving axles, heavy grades can be traveled much more easily and quickly than is possible by train haulage

Both single- and double-truck cars have been used in this improved method of transportation. Equal flexibility is possible with either type of car.

Another advantage of this haulage system is that the load is carried over the driven wheels. Thus steeper grades can be climbed than is possible by engine haulage.

A haulage system built and operated along the general lines described above is now being used at the Palmer mine of Pickands, Mather & Co., in Michigan. The tower operator causes the cars to start, run, coast, retard, or reverse their direction of travel at will. An important labor saving is thus effected. No train crews or car operators are necessary. The control equipment on the shovel does away with much labor in shifting and spotting the individual cars; an empty one can readily be made to take the place of a loaded car, and the shovel is kept busy. Operating records show that two shovels thus served have the capacity of three shovels supplied with cars by the usual method. Fewer cars are maintained in service to handle a given tonnage, as the productive car-miles or car-hours factor is greatly increased. The loss due to cars standing idle while a car is being loaded, which occurs in every form of train operation, effects both the number of cars required and the labor of supervising car movements. It is, however, eliminated with the individual motor-driven, centrally controlled electric car through the decrease in necessary equipment.

This system, which is known as the Woodford system, is said to be adaptable to any form or type of open-pit or quarry operation, especially where heavy grades are encountered, as all functions of a railroad are performed and all railroad operating conditions are met exactly as if an operator or engineer were on each car.

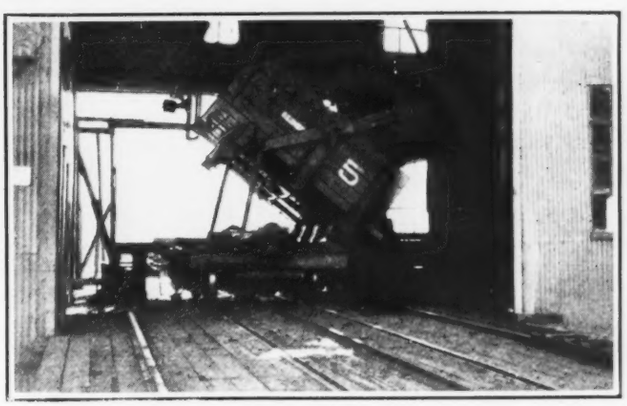


Fig. 5—At the dumping point the unloading operation can also be made automatic, thus cutting operating costs and assuring a uniform feed to the crushers

Respirators Used in Dusty Headings by McIntyre Porcupine

The use of respirators after blasting at the McIntyre Porcupine Mines, Ltd., at Schumacher, Ont., is described by S. A. Wookey in the National Safety Council's "Mining Section News Letter" for March.

All development work at this property is done on a contract footage basis, according to Mr. Wookey, and two men drill and blast a 6- to 7-ft. round daily. Work is carried on by two shifts working from 7 to 3 o'clock day and night, with a four-hour interval, and blasting is done at the end of each shift, the number of faces blasted on each shift being approximately equal. The four- to six-hole diamond or pyramid cut is used in all places, and it is usually necessary to blast the cut twice, or even sometimes three times, before the remainder of the round is loaded and shot.

The cut is blasted with from forty to fifty sticks of 40 per cent gelatin, and a water blast, consisting simply of a cross connection with a controlling valve between the air and water lines some distance back from the face, is turned on after spitting the fuses.

After five to fifteen minutes the men return to the face to reblast the cut if necessary, or to load and blast the rest of the round. They are in this smoky and dusty atmosphere for from twenty to thirty minutes.

Konimeter dust counts in the face after the cut has been blasted once show a concentration of about 5,000 particles per cubic centimeter. Upon reblasting the cut the second time, this count has increased to about 8,000 to 10,000 particles per cubic centimeter.

Dust From Blasting Is of Uniform Fineness

The dust from blasting is remarkable for its uniformity in fineness and averages about 90 per cent minus 2.5 microns. Certain experiments were carried on, using different plies of ordinary dry gauze bandage as a filtering medium, and it was found that from 75 to 80 per cent of the dust was removed by such a crude filter. After further tests, a respirator was decided upon, and this appeared to be an advance over the old sponge-type muzzle.

The respirator consists of a light rubber mask covering the mouth and nose and held to the face by adjustable elastic bands. Two exhaling valves are fitted to the mask, and all air breathed is drawn through a cotton filter fitted to the front of the mask. The filtering medium consists of a round, long-fiber cotton disk 2¾ in. in diameter, which is held in place by a screwed metal cap. The whole mask is light and not uncomfortable, and one breathes without difficulty.

The dust counts using the respirator are as follows:

First blasting of cut—
- Four holes—40 sticks 40 per cent gelatin powder.
- Konimeter count—approximately 5,000 particles per c.c.
- Konimeter count—1 thickness of filter, 800-1,000 particles per c.c.
- Extraction—80 per cent.

Second blasting of cut—
- Four holes—35 sticks 40 per cent gelatin powder.
- Konimeter count—approximately 8,000-10,000 particles per c.c.
- Konimeter count—1 thickness filter, 1,000 particles per c.c.
- Extraction—80 per cent.

It is evident, therefore, according to Mr. Wookey, that with the enormously high concentrations of dust after blasting, although the filter removes 80 per cent of the dust, the amount passing through the filter is still much above the safe limit when one thickness of the filtering medium is used.

It was found on further experiment that by inhaling through two thicknesses of filter about 80 per cent of the dust passing through the first thickness was caught on the second, giving a total extraction of about 96 per cent.

No difficulty was experienced when inhaling through the double filter, and it is interesting to note that the efficiency of the filter improves as the filtering medium becomes damp from the exhaled breath and from having the interstices filled with dust. It was found that after about half an hour it became difficult to breathe and the filters had to be changed.

A gravimetric check on the amount of dust breathed was interesting and showed that in such high concentrations the konimeter gave about 50 per cent of the true count. The data obtained are as follows:

Time of exposure—20 minutes.

Resulting weight of single thickness of filter	40.5 mg.
Less weight of ash	.5 mg.
	40.0 mg.

The average size of the particles was taken as 2.6 microns, which, according to a table in the Final Report of the Phthisis Commission of South Africa, gave 14,000,000 particles per m.g. If a man breathes one cubic foot of air per minute, the dust count works out at about 10,000 particles per c.c. This compares to a konimeter reading of 5,000 plus per c.c.

A simultaneous test taken over seven minutes in an evidently higher concentration of dust gave the following results:

Exposure—seven minutes.

Resultant weight of a single thickness of filter	25.5 mg.
Less weight of ash	.5 mg.
	25.0 mg.

Calculated number of particles of dust present 17,500 per c.c.
Actual konimeter count, approximately 10,000 per c.c.

No difficulty was found in making the men wear these respirators, and it is now compulsory that all machine men and helpers use them after blasting the cut and re-blasting and loading the square-up.

Double Filter Effects Extraction of 96 Per Cent

A single thickness of filter is from 80 to 85 per cent effective, but with the dust concentrations met with after blasting, an amount much in excess of a safe limit passes through the filter. With a double thickness of filter, a further 80 per cent of the amount passing the first filter is caught, making a total extraction of about 96 per cent.

Doctor Mavrogordate points out that a certain amount of inhaled dust is constantly eliminated, and it is only when that amount passes a certain limit that invasion gets ahead of elimination, and accumulation occurs. Further, he suggests that intermittent exposure to relatively dense clouds is the deciding factor in producing silicosis in susceptible human subjects. It is very evident, therefore, that the respirator to a large degree eliminates this danger.

Cartersville

An Important Mining Center of the South

By Albert H. Fay
Mining Engineer, New York City

Albert H. Fay

CARTERSVILLE, GA., is the county seat of Bartow County and is the center of the Cartersville mining district, 48 miles northwest of Atlanta, Ga. It is served by three railroads. The town and district are well supplied with electric current by the Southeastern Power Co., of Alabama, owning various water-power developments in the Southeastern States, and capable of furnishing unlimited electric power to all industries located in that territory. The mining district is about 5 miles wide and 20 miles long. It is the largest producer of ochre and the largest shipper of crude barytes in the United States, and ships minor quantities of manganese, manganiferous iron, iron ore, and bauxite. Limestone and roofing slate are also important products. There are in the district deposits of potash-bearing slate and shales, which may eventually constitute a source of potash for the fertilizer industry.

Cartersville was one of the bidders for the location of the plant which was finally placed at Muscle Shoals. There were 120 applicants for the location of this plant, and Cartersville, Ga., was one of five held under last consideration by the officials in charge of locating the plant. The Etowah River, on which this town is located, is capable of furnishing at least 50,000 hp., the rights of which are owned largely by the Southeastern Power Co., which has not as yet developed the potential power.

The iron deposits of the district have been known since Civil War days, and during that period a furnace was operated only a short distance from Cartersville. This furnace was built of stone, and is still standing in a fairly good state of preservation. The first manganese was shipped from the district in 1866.

Barytes Industry of Recent Development

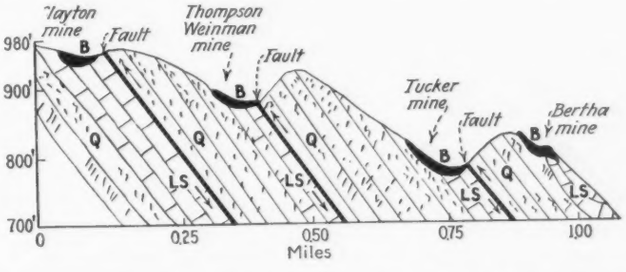
The barytes industry at Cartersville, Ga., is comparatively new. A small amount of barytes was mined and shipped prior to 1907. I spent some time in the district in 1907 and 1908, at which time mining was all done by hand labor, pick, shovel, and wheelbarrow. Shallow overburden was often removed by team and scraper. In this way only exceptionally rich deposits could be worked at a profit. As a result, operators were loath to extend operations. At that time I recognized the fact that though the rich deposits were meager, the mineral-bearing areas contained a high percentage of small pieces of barytes that could not be saved by the hand-mining methods then in vogue, and recommended that the steam shovel and log washer be used in combination in order to handle all of this material in quantity. The same conditions existed at Sweetwater, Tenn., where steam-shovel operations were also recommended.

A lapse of twenty years has shown a marked improvement in mining methods; one to three steam shovels are operating in each pit or deposit, and all the clay containing 8 to 60 per cent barytes is mined and sent through log washers, where practically all of the barytes, coarse as well as fine, is removed.

The operations have reached such a stage that barytes mining is now one of the dependable industries of the district. It assures steady employment to local labor, a regular supply of outgoing freight to the railroads, and a substantial income to the operators and to owners of the land who have leased to the producing companies. The price of both fee and royalty has increased from a farm land value and 25c. per ton to thousands of dollars per acre and $1 per ton of shipping ore. Minimum royalties are also exacted in case shipments are not made. Prior to 1917 clay containing less than 15 per cent barytes was not considered commercial. Now less than 10 per cent material is being put through the washers, and a reasonable profit is being made therefrom.

Character of Deposits

According to the State Geological Survey, the barytes deposits may be classified into six types, according to their mode of occurrence: (1) veins; (2) replacement; (3) breccia; (4) residual; (5) colluvial, and (6) alluvial. The first three are found in hard rock

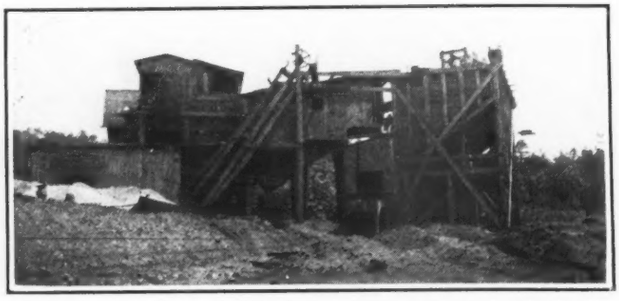


Cross-section showing relation of barytes deposits to the quartzite and limestone (after Hull). B, barytes; Q, quartzite; Ls, limestone.

formation and so far are of no commercial importance except as the source from which the residual, colluvial, and alluvial deposits have come. Hull[1] states:

"Residual deposits form the only profitable workable barytes deposits in Georgia. By the term 'residual' it is not intended to restrict the definition of these deposits to orebodies that have been left behind, *in place*, by the wearing away of the mother rock, but it is intended also to embrace those other fragmental accumulations that have

[1]J. P. D. Hull: "Report on the Barytes Deposits of Georgia." Bull. 96, Geological Survey of Georgia, p. 14.



No. 1 washer, Paga Mining Co.

been added to the strictly residual deposits and have thus been concentrated in unconsolidated materials by long-continued weathering agencies such as frost action, hillside creep, and gully wash. Thus it is seen that the residual deposits contain some colluvial or hillside accumulations, and in places where ancient stream channels and beaches have been cut, hillside erosion may contain some alluvial or water-born accumulation. All of these are fragmental and secondary in nature. The term 'residual' seems most applicable, in that these accumulations are generally in the red and yellow soil mass that overlies or represents the ore-bearing rock, which is as a rule limestone."

Colluvial deposits are the unconsolidated accumulations formed by the wearing away of a hillside and still occupy lower hillside positions. The ore-bearing beds that were tilted and folded in the formation of the hills gradually disappeared in disintegration and decay, and the heavy ore, released from the hard rock, slowly migrated down the hillside as loose deposits that increased as the rocks wore away. Since the colluvial deposit is a gradual accumulation of strictly residual ore, it cannot be definitely separated from a residual deposit.

The principal exploited barytes deposits of Georgia are confined to the southern part of the Cartersville district, comprising an area about 6 miles long and 3 miles wide, extending from Pumpkinvine Creek on the south side of Etowah River to the mines northwest of Pine Mountain on the north side of the river.

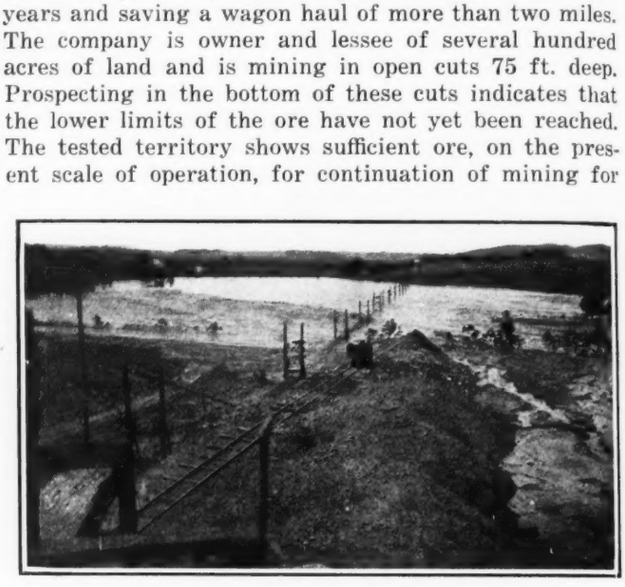
The accompanying illustration[2] shows a cross-section extending from the Clayton mine through the Bertha mine, north of Etowah River. To quote again from Hull:

"Within this distance of a mile there are three quartzite ridges with intervening valleys representing limestone that has been eroded. All of the determinable dips are to the east. All of the large ore deposits which are principally barytes are on the eastern slope at the base of the decomposed limestone overlying the quartzite. The small fault traces necessary for the explanation of this structure must be in the east side of each valley and at the western base of each hill."

Producers of Barytes

Four producing companies are operating in the Cartersville district and shipping substantial amounts of barytes.

The Paga Mining Co. is a Georgia corporation owned by W. J. Weinman and others. This company produced last year 46,178 tons of crude barytes, and is the largest individual shipper of barytes in the United States. It employs six steam shovels and 100 men, and operates its washing plant by electricity furnished by the Southeastern Power Co. The washed ore is carried by aërial tramway to the Thompson-Weinman mill on the Etowah River, from which point it is shipped as crude ore, or ground at the mill. The tram from Paga Mine No. 2 to the railroad is one mile long and carries eighty 4-wheeled cars having a capacity of 600 lb. each, operated by a 15-hp. motor on a steel cable track. The line from Paga No. 2 to Paga No. 1 is ⅝ mile long and has twenty cars carrying 750 lb. each and operated by a 10-hp. motor. This method of transportation has proven very satisfactory, having been in operation more than seven years and saving a wagon haul of more than two miles. The company is owner and lessee of several hundred acres of land and is mining in open cuts 75 ft. deep. Prospecting in the bottom of these cuts indicates that the lower limits of the ore have not yet been reached. The tested territory shows sufficient ore, on the present scale of operation, for continuation of mining for the next twenty-five years, with additional territory to be prospected in the future.



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[2]*Op cit.*, p. 30.

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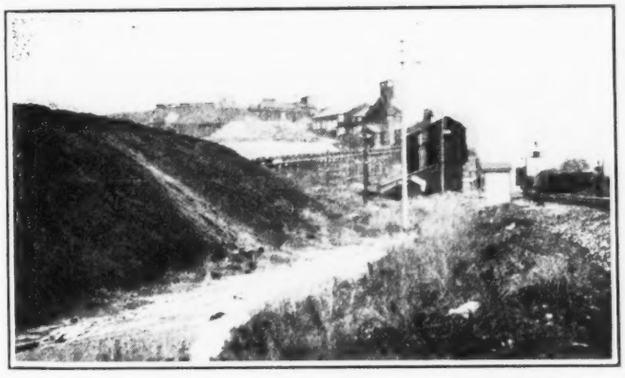

Washing plant, New Jersey Zinc Co. embankment of mud pond at left.

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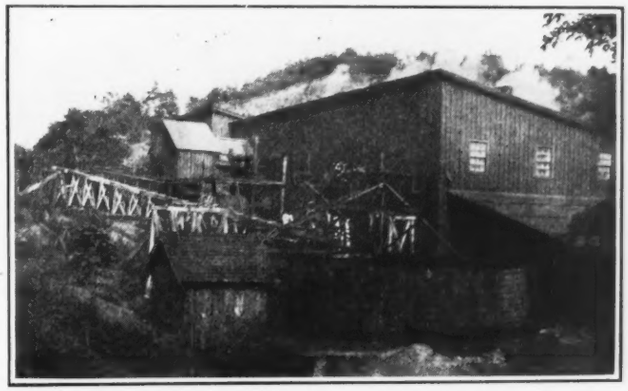
There is only one fine-grinding plant in the district, that of Thompson, Weinman & Co. This company grinds, refines, manufactures, and ships inert pigments for use in the paint and rubber trades. Its customers are scattered throughout all states east of the Mississippi River. This company produces annually about 45,000 tons of various pigments and employs an average of sixty men. The firm is a Georgia corporation owned by W. J. Weinman, of Cartersville, Ga., and the estate of S. M. Evans, Essex Fells, N. J. Mr. Weinman is president. This company does no mining, but secures its crude ore largely from the Paga Mining Co.

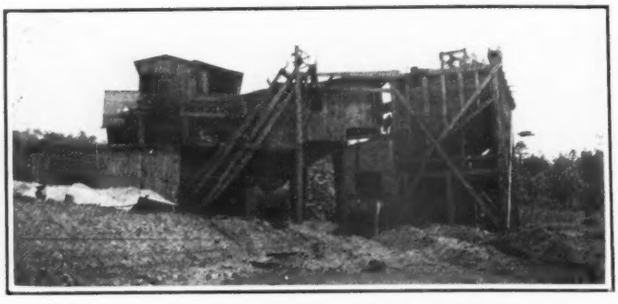
Thompson, Weinman & Co.'s grinding plant is located on the Etowah River about 1½ miles below Cartersville. The power dam across the Etowah River is 10 ft. high and 340 ft. long. Equipment at the power plant consists of two 69-in. water wheels and one 45-in. water wheel, generating 900 kilowatts.

The ore for grinding whiting is first crushed through a No. 3 gyratory crusher, and from there goes through a hammer mill and is pulverized to about 40 mesh. From this mill it is conveyed into a large storage tank located between the two Hardinge mills, and from these tanks it is fed into the Hardinge mills, ground in water, and pumped to an 8-ft. classifier. The overflow from the 8-ft. classifier flows into a 12-ft. classifier. From there it is pumped to a 25-ft. settling tank, and thence to a feed tank which flows by gravity to four drying cylinders that are charged with live steam. As the cylinders revolve the dried material is scraped off the driers and conveyed to a Raymond beater mill to thoroughly disintegrate the clotted particles. It is then packed in 100-lb. and 50-lb. paper bags.

The dry grinding media for grinding barytes and



Main section of plant of Georgia-Peruvian Ochre Co.



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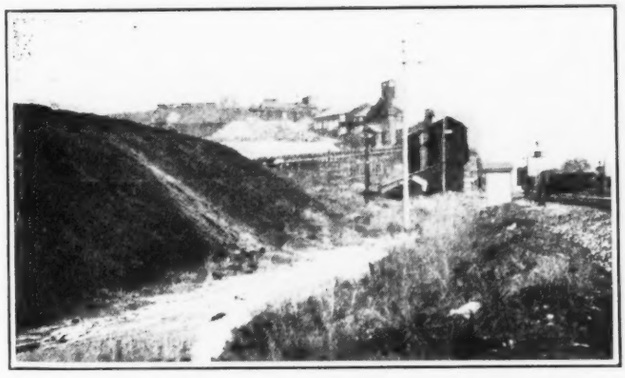

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All of the barytes produced is washed free of clay by log washers, and the system used by all the producers is practically the same. The ore is delivered by steam shovels into tram cars and to the washing plant, where it is run through a revolving machine that breaks up the clay in which the ore is contained. It is then run through the log washer, screened, and the oversize delivered to a picking belt, where all waste rock is removed. The fine ore from the screen is run through jigs and the lump hand-picked ore goes direct to the bins. Large settling or slime ponds are maintained to receive the clay that is removed from the barytes. The disposition of the waste dirt is a real problem, and one that entails no small expense.

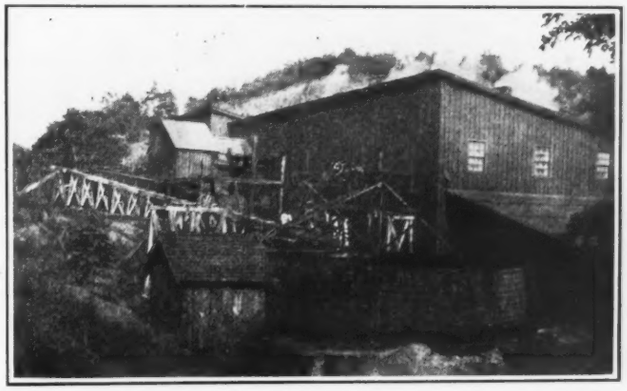
There is considerable waste at the log washer, jigs, and grinding plant due to sliming, but it is absolutely necessary to rid the ore of the last vestige of clay and iron, and until a better method is devised the present practice will have to suffice. The hutch product from the jigs, though not very large, contains about 60 per cent barium sulphate. This is often used for surfacing roads. The rock that goes to the waste pile from the picking belt also often contains a good percentage of barytes, but the barytes is so mixed with chert and iron that it cannot be separated. I have no data to show the total loss in washing and grinding, but it is considerable.

There is only one fine-grinding plant in the district, that of Thompson, Weinman & Co. This company grinds, refines, manufactures, and ships inert pigments for use in the paint and rubber trades. Its customers are scattered throughout all states east of the Mississippi River. This company produces annually about 45,000 tons of various pigments and employs an average of sixty men. The firm is a Georgia corporation owned by W. J. Weinman, of Cartersville, Ga., and the estate of S. M. Evans, Essex Fells, N. J. Mr. Weinman is president. This company does no mining, but secures its crude ore largely from the Paga Mining Co.

Thompson, Weinman & Co.'s grinding plant is located on the Etowah River about 1½ miles below Cartersville. The power dam across the Etowah River is 10 ft. high and 340 ft. long. Equipment at the power plant consists of two 69-in. water wheels and one 45-in. water wheel, generating 900 kilowatts.

The ore for grinding whiting is first crushed through a No. 3 gyratory crusher, and from there goes through a hammer mill and is pulverized to about 40 mesh. From this mill it is conveyed into a large storage tank located between the two Hardinge mills, and from these tanks it is fed into the Hardinge mills, ground in water, and pumped to an 8-ft. classifier. The overflow from the 8-ft. classifier flows into a 12-ft. classifier. From there it is pumped to a 25-ft. settling tank, and thence to a feed tank which flows by gravity to four drying cylinders that are charged with live steam. As the cylinders revolve the dried material is scraped off the driers and conveyed to a Raymond beater mill to thoroughly disintegrate the clotted particles. It is then packed in 100-lb. and 50-lb. paper bags.

The dry grinding media for grinding barytes and



Main section of plant of Georgia-Peruvian Ochre Co.

Adit entrance in Georgia-Peruvian ochre mine.

mica are two four-rolled Raymond mills, which grind off-colored barytes, which is not bleached. The barytes coming from the mine in cars goes into a No. 3 gyratory crusher and from there to a Raymond mill. Mica is treated in the same way. A small tonnage of ground barytes is washed, then placed in large lead-lined tanks, and boiled with sulphuric acid for twenty-four hours to bleach out any remaining iron. When taken from these tanks it is washed again and dried, and goes to the Raymond mills to be ground to a 300 mesh product, and later packed in bags.

The mill building is being remodeled and built of cement and concrete and new machinery will be installed as rapidly as is consistent without interrupting production. There is a spur track from the main line of the N. C. & St. L. railroad running into the mill building, making convenient facilities for loading and unloading all materials and finished products.

Uses of Barytes

The principal use of barytes is in the manufacture of lithopone, wherein the soluble barium sulphide is brought into contact with zinc sulphate, producing insoluble intermixed precipitates of barium sulphate and zinc sulphide. Lithopone is used as a pigment in paints, a filler in linoleum, oilcloth, and rubber, and as an enamel for papers such as heavy book paper, playing cards, and bristol board. The next important product is the ground barytes, which is also used as a filler for rubber, linoleum, oilcloths, and various papers. It is also used in the paint industry and finds application in a number of other industries where a heavy filler is required. Ground barytes does not make as smooth a pigment for paint as does the precipitated lithopone.

Barium is used extensively in the chemical industries, and, as barium peroxide, is used in the preparation of hydrogen peroxide. As a chloride it finds its greatest chemical use, as in this soluble form it is the basis of many other barium salts. As a nitrate and chlorate it is used as one of the ingredients of certain pyrotechnic products.

Production of lithopone increased from 93,000,000 lb. in 1915 to 290,038,000 lb. in 1925. In 1918 about 46 per cent of the crude barytes was used in the manufacture of lithopone. This has increased until in 1926 approximately 70 per cent was so used. The value of this product in 1925 was $15,186,147. Since lithopone is 70 per cent barium sulphate, the rapid increase in production in recent years is of prime importance to the miners of barytes. From 20 to 25 per cent of the crude barytes is used in the ground form and 8 to 10 per cent in the chemical industries.

Ochre Deposits

The ochre deposits of the Cartersville district occur in connection with the limestone and quartzite formation and are closely associated with barytes and manganese. Ochre is the soft earthly hydrated ferric oxide, limonite, $2Fe_2O_3 \cdot 3H_2O$. The yellow ochre of the Cartersville district is the only ochre of similar grade in the United States. The ochre-bearing area is about eight miles long and not to exceed two miles in width. It extends north and south and crosses the Etowah River about two miles southeast of Cartersville. At this point there is an excellent exposure of ochre, and here is the largest mine in the district. According to Watson[3] the ochre is almost entirely limited to the Wisner quartzite. The color of the ochre varies from a dark to light bright yellow, depending largely upon the amount of clay mixed with it. When ochre replaces quartzite, it is light in color, whereas that which occurs near or interbedded in shale is dark and of an inferior grade. Silica is a constant impurity, but, being hard and gritty, it is easily removed by proper washing. Manganese is also an impurity, but to a lesser extent. When present in small quantity as an oxide, it imparts a greenish tinge to the otherwise yellow ochre.

Crystalline barytes is frequently found in the ochre deposits, but is easily removed in the log washers. One of the surface indications of an ochre deposit is the occurrence of fragments or even ledges of ochre-bearing quartzite; another indication is the occurrence of residual barytes which is usually associated with the ochre. Where the surface of the ground is the residual clay soil, it is only by sinking test pits that ochre may be found. Whenever prospecting has been carried on in places containing barytes, almost invariably deposits of ochre have been found, varying of course in extent and quality. It would therefore seem that so long as new deposits of barytes are found so long will ochre deposits be available.

Ochre was first mined in this district in 1877, by E. H. Woodward, and the first shipment of fifty tons to Europe was made in 1890. The principal use for this high-grade yellow ochre is as an essential ingredient for lincleum and oilcloth by manufacturers in the United States, Scotland, England, and the European countries. It is also extensively used as a mineral paint. It is somewhat darker than the French ochres, is more durable in color, and is said to be the only ore of its kind in the United States that furnishes a permanent yellow ochre. When calcined this ochre makes a bright-red pigment.

The Georgia-Peruvian Ochre Co. was formed in 1890 and was the first company to make substantial shipments. This company has a large, modern plant on the Etowah River about 1½ miles north of Cartersville, owns several hundred acres of land, uses electricity

[3]Thomas L. Watson: "Ochre Deposits of Georgia." Bull. 13, Geological Survey of Georgia, 1906.

from the Southeastern Power Co., and employs sixty men, producing from 10,000 to 12,000 tons of ochre per year. The ochre is mined by underground methods, and after the silica has been removed by log washing the ochre slime passes through classifiers and thickeners, and is finally sprayed on cylindrical rotary driers, steam heated, where it is dried. This finished product is removed from the driers by scrapers and carried to storage bins, from which it is packed in barrels or bags for shipment.

The Blue Ridge Ochre Co. owns forty acres 2½ miles east of Cartersville. The mine was operated for many years, shipping its product principally to customers in England and Scotland until the beginning of the World War. During the war ocean freight rates increased to such an extent that it was impossible for this property to continue shipments to its European customers. Though the company has not been operating for a number of years, it is still a potential source of a goodly tonnage of ochre.

Cherokee Ochre Co. began business as the Cherokee Ochre & Barytes Co. in 1894. The company leases its barytes deposits to the New Jersey Zinc Co., and operates its own plant solely for yellow ochre. This plant is less than a mile east of Cartersville. The company owns 170 acres of land and does its mining entirely by open-cut methods, employing about twenty men. It has operated continuously without shutdown for more than twenty years, shipping from 2,000 to 4,000 tons per year, with a large tonnage in reserve.

The New Riverside Ochre Co. property is situated about 1½ miles east of Cartersville, on Etowah River, and consists of seventy-five acres of land. It operates regularly, being largely owned by the Armstrong Cork Co., Lancaster, Pa. This company mines barytes, in addition to ochre, employs twenty men and ships from 2,000 to 4,000 tons of ochre per year.

Iron Mining

Before the Civil War iron was mined extensively in Bartow County, the first work being done about 1840. In 1853 there were five furnaces producing from two to four tons of charcoal iron per day. In 1874 a fifty-ton furnace was erected at Rising Fawn, and the Bartow County furnaces were closed down in the 70's. Since 1890 slightly over 3,000,000 tons of iron ore has been produced in Georgia, the larger part of which came from Bartow County. The largest annual production was in 1907, when 337,229 tons of limonite was produced. The major portion of this limonite ore in Bartow County is associated with the Knox dolomite and Weisner quartzite and at Cartersville is found in or near faulted areas. Barytes and manganese are often associated with the limonite, and especially in the soft ochre deposits. Though the deposits are not comparable in size with those of Minnesota, or even of Alabama, yet the ore is high grade, being low in phosphorus and high in iron. These deposits represent potential reserves and are a valuable asset to the district. They have been fully described by Hazeltine.[4]

The principal ores of manganese occurring in Georgia are pyrolusite, psilomelane, wad, and manganite—all oxides. In addition to these are deposits of manganiferous iron ores containing 5 to 15 per cent manganese. The principal deposits are in Bartow County within well-defined areas on the west of the Cartersville fault in a narrow belt 1½ miles wide and 18 miles long. Deposits that have been worked are found in an area of about 30 square miles. The manganese mines were inactive from 1906 to 1915, in which latter year 168 tons was produced. In 1918 about 5,000 tons of 40 per cent ore was produced. In addition to this, in 1917 a total of 14,000 tons of manganiferous ore of 5 to 15 per cent manganese was shipped, and in 1918, 17,000 tons of the same character of ore. Since the World War, little has been done, but the activities during the war show that the deposits are potential reserves in case of emergency and high prices. These deposits have been fully described by Hull and La Forge.[5]

The largest and best-known manganese deposit in the Cartersville district is the Dobbins property. It consists of about 640 acres, and mining has been carried on intermittently since 1866, when the mine was operated by the Pyrolusite Mining Co., with a production of 550 tons for that year. The property is still in operation in a small way, shipping a few hundred tons per month. It is reported that from the early part of 1916 to the beginning of last year the owners had returns made by their various leases of more than 53,000 tons of manganese and manganiferous ores shipped from this property.

Another mine that has produced considerable manganese is the Hall property on lot No. 405 in the Cartersville district. This contains about thirty-nine acres of land, one mile east of Cartersville, and was operated by the Republic Iron & Steel Co. from 1917 to 1922 without steam shovels or any other improved machinery, the mining being wholly done by hand labor with picks and shovels. During this period more than 16,000 tons of manganese and manganiferous ore was produced and shipped. Development work shows a goodly tonnage still available. This same property also contains a deposit of barytes which is under lease to the New Jersey Zinc Co.

The R. K. Miller Minerals Co. is the owner of eighty acres of land two miles northeast of Cartersville, and is preparing to operate under a Delaware charter. Work

[4]R. A. Hazeltine: "Iron Ore Deposits of Georgia," Bull. 41, Geological Survey of Georgia.

[5]J. P. D. Hull, Laurence LaForge, and W. R. Crane: "Manganese Deposits of Georgia," Bull. 35, Geological Survey of Georgia.

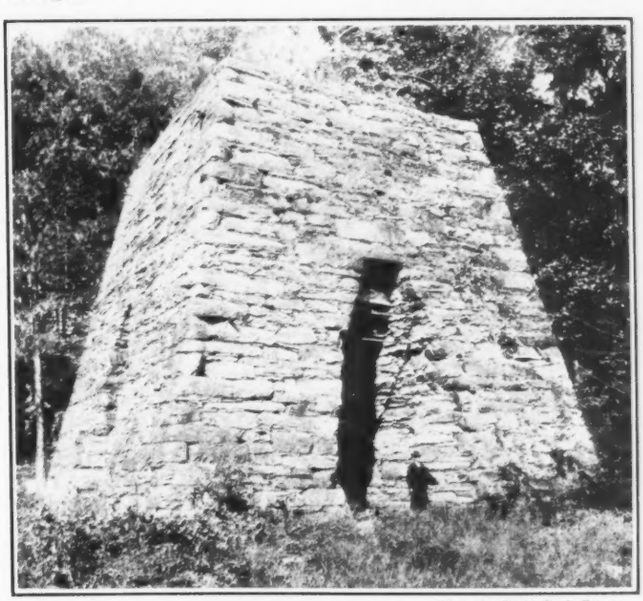


Photo by State Geol. Surv.

Iron furnace on Etowah River, near Cartersville, operated prior to 1865.

on this property has just begun with the running of a number of small tunnels and the installation of two washers and jigs. This deposit, in addition to manganese and manganiferous iron, contains some barytes. The company plans to mine and separate the materials so as to have at least two shipping products—namely, barytes and manganese. By close selection it will be possible to ship a product containing 35 to 40 per cent manganese. This mine was formerly known as the R. B. Satterfield property, and was referred to in the 1917 report of the State Geological Survey as producing 33 per cent manganese, while the property was being worked for barytes.

Slate Deposits

About 15 miles northeast of Cartersville is a large slate deposit, which though not sufficiently fissile to produce a high-grade roofing slate, finds a market as a crushed slate for use in the manufacture of composition shingles. The slate quarry is owned by Richards & Co., of Cincinnati, Ohio, and is open to a depth of 100 ft. In the bottom of the pit are two steam shovels to load the crude slate into buckets that are transported by a 900-ft. aërial tram to the grinding plant. Of the raw material handled about 40 per cent is wasted as fines before the finished product of 3,000 to 4,000 tons per month is delivered. Some of the fines find a market as a filler for fertilizer. The crushed slate is in flakes of $\frac{1}{8}$ to $\frac{3}{16}$ in. in diameter and of a greenish color. By certain firing processes and the use of coloring materials, six shades of slate are produced. The major colors are blue, brown, and red of various shades, which are said to be permanent.

The amount of roofing slate that has been produced in Georgia is comparatively small, in some years amounting to 3,000 squares. Since 1907 there has been practically no production. The slate deposits have been described in detail by Shearer.[6]

Potash-Bearing Slate and Shale Deposits

A number of companies have interested themselves at various times in the extensive potash slate deposits in the Cartersville district. Among these may be mentioned the American Potash Co., the American Metal Co., the Vithumus Co., and the Georgia Potash & Chemical Corporation. These slate and shale deposits carrying potash have been described in detail by Shearer[7], who says:

> "The chief value of the formation seems to lie in its high potash content. Some silicate minerals contain higher percentages of potash, but at no other place except in the Leucite Hills of Wyoming is there known to be such an enermous tonnage of easily workable material containing 8 per cent or more of potash."

A number of processes that have been developed and patented for the extraction of potash from silicate minerals have been described by Galpin[8], some of which should be applicable to these slates.

Bauxite

There are also bauxite deposits in the Cartersville district, one of which is 16 miles west of Cartersville and is now being developed by the General Abrasives Co., of Niagara Falls, N. Y. The mine is in charge of William J. Crouch, Adairsville, Ga. The Akin property in the northwest part of the country was operated for a period of years by the Republic Mining & Manufacturing Co., and substantial shipments of bauxite were made.

Limestone

The Ladd Lime & Stone Co. conducts extensive quarry operations about four miles from Cartersville, its chief product being limestone for road materials and railroad ballast. It also burns a large quantity of stone and produces a high-grade lime. This quarry has been worked almost continuously for fifty years. The crushing and loading plants are operated entirely by electricity and handle about 800 cu.yd. of material per day. About 125 men are employed. This is one of the permanent industries of the district.

[6] H. K. Shearer: "The Slate Deposits of Georgia," Bull. 34, Geological Survey of Georgia.
[7] *Op. cit.*
[8] S. L. Galpin: "Feldspar and Mica Deposits of Georgia," Bull. 30, Geological Survey of Georgia.

History of Diamond Drilling

According to Frank A. Edson, in Bulletin 243, U. S. Bureau of Mines, the diamond drill, which was invented about 1863 by Robert Leschot, a French engineer employed on the Mont Cenis Tunnel, is the oldest form of core drill. In his youth Leschot had been a watchmaker and had thus become familiar with the wearing qualities of the jewels in watches. Observing that the steel in the bits used to bore holes for blasting wore out quickly in the hard rock, he conceived the idea of setting diamonds in the bits to make them wear longer, probably using, at first, white diamonds instead of the black stones.

The diamond drill was first used in the United States during the late 60's at the Vermont marble quarries, before the steel saw had been invented for cutting out blocks of marble. Instead of a steel saw being used to cut the marble into blocks, as is now the practice, a series of small diamond-drill holes was bored along the line of the slab. According to T. L. Dee, of the Sullivan Machinery Co., Chicago, Ill., some of these machines were so built that they rotated two bits simultaneously. As soon as one pair of holes was finished, the machine was moved a little more than the diameter of the hole and another pair of holes was drilled; in this way a cut was made along practically the entire length of the slab. This bit, known as a bore head, was solid and cut no core. M. C. Bullock, organizer of the Bullock Machinery Co., saw the advantage of this drill for prospecting and bought the American rights to the Leschot patent.

The earliest exploration work with the diamond drill was probably in the Pennsylvania coal fields. Coxe[1], writing in 1872, described a very deep hole (700 ft. deep), sunk by the diamond drill. It is interesting to contrast this hole with the 7,347-ft. hole drilled with a diamond drill by the Imperial German Government near Czuchow, Upper Silesia, Germany, in 1909.

In the early 70's the diamond drill was used in drilling holes for blasting out the well-known Hell Gate Reef, which long had menaced navigation in New York harbor. About that time the Michigan copper and iron ranges were being explored and developed, and the diamond drill was first used extensively there. The Bullock Machinery Co. was later sold to the Sullivan Machinery Co., which owned the chief patents on diamond drills until they expired. Although many details have been changed, appreciably the principles of diamond drilling have not changed since the diamond drill was first used.

[1] Coxe, Eckley B.: "A New Method of Shaft Sinking." *Trans.* A.I.M.E., Vol. 1, 1871-1873, p. 275.

Steam Hoist Altered to Motor Drive

Change Made Without Interfering With Operations at Kennedy Mine, on Mother Lode, in California

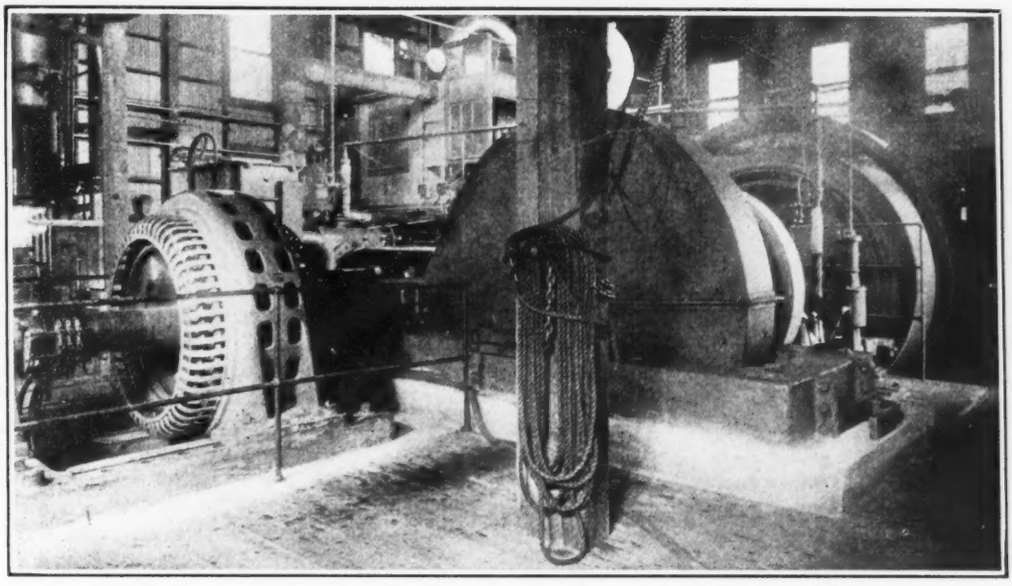
Conversion of a direct-connected, 28 by 60-in., double-drum steam hoist into a motor-driven hoist was recently made at the Kennedy mine, at Jackson, Calif., in such a way as not to interfere materially with mine operation. The original hoist was installed in 1902. At that time the Kennedy mine had reached a depth of 2,300 ft. The shaft is vertical. In the twenty-four years intervening the working shaft has been deepened in successive stages until it is now 4,600 ft. in depth, the lowest level being at 4,500 ft. and the additional 100 ft. serving as a sump.

The steam hoist was designed to operate at a depth of 4,000 ft. and to supply a 100-stamp mill. It was equipped with double drums provided with friction clutches for independent operation. Post brakes were operated by steam. The hoist operated satisfactorily and was used for unwatering as well as for mine operation. However, when the mining depth exceeded 4,000 ft. the hoist began to show some signs of distress, the principal weakness appearing in the clutch disks.

The main shaft of the hoist is in three sections. New end shaft sections, clutch disks, and engine-crank disks were used to replace the old ones, steel being used for all of the parts. The crank disks were also made of steel and bored with holes near the periphery in anticipation of using them for motor connections at some future time. Oil fuel was used in the boiler plant. Air compressors were also operated by steam power. A few years ago a 335-hp. synchronous-motor-driven air compressor supplanted one of the steam-driven compressors and last year a 225-hp. synchronous-motor-driven compressor displaced the other.

The conversion of the hoist from steam to electricity was effected in a comparatively simple way. It was desired to make the arrangements such that steam operation could be resumed under emergency conditions. The plan therefore included the placing of a Falk herring-bone-gear speed reducer in line with the driving shaft of the hoist and a motor, offset from the axial line. Concrete foundation blocks for both speed reducer and motor were constructed, and both were mounted in position alongside of the hoist. All other apparatus, consisting of a liquid type controller, Lilly hoist controller, and accessories, were erected. When completed the steam hoist was shut down on a Saturday, the connecting rods were removed, and a special spider was interposed between the coupling plate of the gear drive and the crank disk. These three were bolted together, and the hoist was placed in successful operation on Monday morning.

The crank disks are 7 ft. in diameter and were provided, as mentioned before, with 16 holes, 1½ in. in diameter near the periphery of the disk. These were reamed out, and 1½-in. bolts used to connect disk, spider, and coupling face-plate of the speed reducer.



Hoist room at the Kennedy mine, Jackson, Calif. Geared to the double-drum hoist is a 750-hp. motor

No changes were made in the drums. By changing the weight of the skips and the load, operation to a depth of 5,000 ft. is now provided. The gear drive is single reduction, consisting of a cast-steel gear, 116-in. pitch diameter and 14-in. face with 174 teeth. The pinion is of forged steel, 12.65-in. pitch diameter, 14 in. face, with 19 teeth.

Gears are inclosed in an oil-tight case and are operated in oil. The motor is of the variable-speed alternating-current type with wound rotor, 2,200 volts, 60 cycles, 3 phase, 440 r.p.m., 750-hp. rating. Maximum unbalanced load or rope pull of the new installation is designed for 15,700 lb. Weights now involved are skip, 6,400 lb.; ore, 6,000 lb.; rope, 5,000 ft., 1⅛ in., weighing 10,000 lb. As greater depth is attained lighter skips are to be substituted, the weight given being that of the old skip. Maximum peak load of motor was figured at 1,285 hp. for unbalanced hoisting. The hoist operates normally as a partially balanced hoist. Speed of hoisting is 1,500 ft. per minute. In operation rope speed is about 1,570 ft. per minute; maximum peak load upon motor is 1,453 hp. at the end of the acceleration period, which is about 20 seconds. The acceleration period was

placed at 12 seconds in the designs. Post brake cylinders were altered to permit of operation with compressed air. In addition a complete meter equipment was installed. This consists of a demand meter and a curve-drawing indicating wattmeter. Limit stops, overspeed, and overwind are taken care of by the Lilly controller.

The hoist on the north shaft of the Kennedy was originally steam and water-wheel driven, and this was changed by removing the engine and water wheel and coupling on a 125-hp. variable-speed alternating-current motor with rheostat control. This hoist operates at 400 ft. per minute.

Rubber-lined Pipes Resist Abrasion at Mine in Malaya—How They Are Made

Considerable attention appears to have been given to the use of rubber for lining launders, pipes, and gravel pumps by the Wilkinson method in Malaya, says *The South African Mining and Engineering Journal*, and a report of pipes lined in this way, at work at the Sungei Besi mine, is given by T. M. Kinnear in a recent issue of the *Industrial Australian and Mining Standard:*

Three rubber-lined pipes, each of 9 in. internal diameter and about 20 ft. long, have been in continuous operation on the discharge line from an 8-in. gravel pump at this mine for a period ranging for eighteen months from the date of installation of the first pipe. These pipes have been subjected to a continuous flow of gravel, amounting to about 17,000 cu.yd. of solids per month, and a working pressure of about 17 lb. per square inch. The three pipes, although differing somewhat in design, are all alike regarding the successful results of the rubber applied to them, there being little or no evidence of wear or abrasion on the rubber after this long period of operation. The life of a lap-welded mild steel pipe $\frac{7}{16}$ in. thick on the same line, with frequent turning to insure even wear, does not amount to an average of seven months.

No. 1 pipe was intended merely as an experimental one, and was more costly and complicated to build than No. 2 pipe, which was installed Nov. 30, 1924. The shell of this pipe is made of mild steel plate $\frac{3}{32}$ in. thick. The half pipe is first bent to the required radius, then an angle iron $1\frac{1}{4}$ in. by $1\frac{1}{4}$ in. by $\frac{1}{4}$ in. is riveted longitudinally along each edge. One face of the angle iron is drilled for $\frac{3}{8}$-in. bolts at distances 12 in. apart, and becomes the means of bolting the halves of the shell together. The flanges are in halves, and are riveted to the shell plate. Crepe rubber is made up into a solid tube consisting of two thicknesses of $\frac{1}{4}$-in. thick sheets, one sheet turn being outside the other, and the butt joints are placed so that they come together roughly on opposite sides from each other. The tube is laid inside one half of the shell, then the other half of the shell is placed on top, and the two are bolted together. Both the shell and the rubber tube were given a liberal coating of rubber solution during the fixing operation. To fix the rubber at the flanges, wood plugs are held in the end of the bore of the pipe, that is inside the rubber tube, and the rubber is cut outside the plug at a distance of $1\frac{1}{4}$ in. from the flange. This $1\frac{1}{4}$ in. is then turned back with a flange ring, which slips easily over the wood plug. The flange ring is recessed on the inside face, this recess being in the form of a taper, which allows the full $\frac{1}{2}$-in. thickness of rubber at the end turn, while it tapers out to nothing just under the bolt holes. The flange ring is fitted with four $\frac{3}{8}$-in. guide pins on the back face; these pins enter four holes in the angle flange, and serve as a guide to keep the flange central when forcing the rubber into position in the recess. The pins are afterward cut and riveted to the angle flange, thus making the flange ring and angle face, as one flange, with the rubber held tightly in the space between them.

No. 3 pipe was installed on Dec. 10, 1925. Except that the shell plate of this pipe is of much lighter gage, $\frac{1}{16}$ in. thick galvanized, it is similar to that of No. 2 pipe. A rubber sheet $\frac{3}{4}$ in. thick is laid in each half of the shell, with the edges brought out between the joint angles. In bolting the two half-pipe shells together, the rubber is pinched between the angles, thus forming a joint. The rubber had a tendency to leave the shell near and below the side joints. However, on opening the pipe for inspection after it had been in operation several days, the rubber was found to be in perfect condition, and adhering permanently all round the shell plate.

A fourth pipe has recently been completed. The pipe embodies a combination of the No. 2 and No. 3 pipes. The shell is practically similar to that of No. 3 pipe, and the method of making and fixing the crepe rubber lining coincides with that adopted in No. 2 pipe. The rubber in this pipe is only $\frac{3}{8}$ in. thick, and is considered ample to withstand the cutting and abrasive action of the sand and water passing through it. The total weight of No. 4 pipe is 443 lb. This is approximately 140 lb. lighter than a flanged mild-steel pipe of the same length and $\frac{7}{16}$ in. thick.

Interesting results, says the South African publication, are expected from certain rubber-lined centrifugal pumps soon to be installed in a West Rand reduction works, and evidence is available that certain outside mines have metallurgical difficulties which might be overcome by the use of rubber linings. Progress to date is, however, small. Rubber linings for tube mills have also had only limited experimental application so far.

Broken Hill Blende Concentrate Roasted for Acid Manufacture

Broken Hill concentrates represent a valuable source of sulphur for the vitriol maker, and to this end a battery of six blende roasting furnaces has been installed at Cockle Creek, according to information in the minutes of the Australasian Institute of Mining and Metallurgy. The furnaces are of the electrolytic zinc barrier roasting type, of a design that originated in Belgium, but which has been considerably modified by the metallurgists of Australia. Each furnace consists of six hearths and a cover arch. Alternate hearths revolve, and rabbling is effected by teeth set in sockets forming part of the hearth above.

The zinc concentrates (the moisture content of which is about 3 per cent, are fed by a screw on to the top hearth and worked down through the furnace, and finally discharged into a conveyor for disposal on the calcine stockpile. No outside fuel is used, the ore once started being kept burning by a careful regulation of the draft, which is supplied by steel fans. The furnace gases, carrying about 5.5 per cent sulphur dioxide, are delivered to the chamber acid plants through steel or cast-iron flues.

How the Fertilizer Minerals of Commerce Are Distributed

By George Rogers Mansfield
Washington D. C.

THE TITLE of this paper implies some discussion of the geology of the fertilizer minerals, but it will not be practicable to dwell on this phase of the subject. It is proposed rather to describe the fertilizer minerals that are important in commerce, to discuss briefly their mode of occurrence, distribution, and production, and to give available data regarding the amount and character of their reserves.

Although the practice of fertilizing land is as old as civilization, it is less than 100 years since mineral substances have been used to any extent for this purpose. Experimentation in the middle and latter part of the last century demonstrated the primary importance of the elements phosphorus, potassium, and nitrogen in plant growth and led eventually to the commercial exploitation of the minerals containing these elements in most readily available form. The principal fertilizer minerals are therefore phosphates, potash salts, and nitrates. A fourth element, sulphur, has been found a necessary adjunct to phosphates, because in the form of sulphuric acid it renders them more soluble and hence more readily available for plant food. Thus, sulphur and pyrite are also classed as fertilizer minerals.

The importance of the fertilizer minerals in world trade may be judged by the fact that in 1924, the last year for which relatively complete figures are available, the total production of these minerals amounted to about 18,256,000 metric tons. This was supplied by thirty-eight countries, some of which produced two or more of the minerals, the United States being the only country to produce as many as four. Two of the mineral groups, potash salts and nitrates, have hitherto been localized largely in Germany and in Chile, respectively, which has given these two countries strategic advantages.

Sources of Information

In this paper the production of the various fertilizer minerals is given on the basis of the figures for 1924, as compiled by the Division of Mineral Statistics of the U. S. Bureau of Mines and by the Imperial Institute, Mineral Resources Department, Great Britain. An attempt is also made to give an idea of the distribution and amount of the reserves of each mineral, but the figures for reserves are much less definite and much more incomplete than those for production. With few exceptions they should not be considered as official. Some of them date back to 1918 or earlier, and they come from various sources, including official government bureaus, consular reports, and articles published by mining engineers and others, compiled under different auspices and with different standards of accuracy. Some are very conservative, others are admittedly large and little more than guesses. They are what the writer was able to gather, and are presented merely as parts of a picture drawn to illustrate some world relationships of the fertilizer minerals.

[1]Read before the general conference, Institute of Politics, Williamstown, Mass., Aug. 12, 1926, and published by permission of the Director, U. S. Geological Survey.

One thing brought out by this discussion is the wide distribution of certain of the minerals, especially phosphates, and the localization of others, particularly nitrates. Another interesting feature is the dominance of the phosphates. This is perhaps fortunate, since of the effective ingredients used in mixed fertilizers in the United States, at least, phosphorus is generally taken in the largest proportions.

Phosphates Widely Distributed

Excluding organic materials, such as bones and guano, and artificial products, such as basic slag, all of which are still marketed to a certain extent, the phosphates of commerce are chiefly phosphate rock. The marketed phosphates occur in a variety of ways, but all may here be classed as residual, replacement, or sedimentary deposits.

Residual phosphates, as the name implies, are the residue of formerly more extended beds of phosphatic limestone, now concentrated by the solution and removal of the contained carbonates, which are more soluble than the phosphates. A good example of this type of rock is the Tennessee brown phosphate.

Replacement phosphates are limestones or other rocks that have been phosphatized or changed to calcium or aluminum phosphates by the action of phosphate-bearing solutions derived from guanos or from igneous intrusions. A good example of this type is the Nauru and Ocean Island phosphate, which is the result of the phosphatization of coralline limestone by guano.

Sedimentary phosphates are no doubt closely related to the other types in origin, but they have accumulated in favorable localities as sediments, interbedded with other rocks, such as limestones or shales. The North African phosphates, the Florida land pebble, and the Western phosphates of the United States are largely of this type, which is now the principal phosphate rock of commerce.

The world production of phosphates in 1924 was about 7,900,000 metric tons. The United States was the principal producer, with 36.79 per cent; followed closely by Tunisia, with 30.19 per cent. Algeria, Morocco, and Ocean and Nauru islands together furnished another 20 per cent, and the remaining 13 per cent was distributed among the other nineteen countries. Russia, whose resources are known to be large, contributed only 0.25 of 1 per cent. Figures for 1925, available for only nine countries, show in general a marked increase over the production in 1924, that for Morocco being most noteworthy with an increase in sales amounting to 67.6 per cent. It is probable that the world's production for 1925 was more than 8,000,000 tons.

Phosphate Reserves

The world's reserves of phosphate may be estimated at about 16,879,000,000 metric tons, sufficient at the present rate of production to last more than 2,000 years. The countries with the largest known reserves in order of rank are the United States, with 6,431,000,000 metric tons; Russia, including Siberia, with 6,235,000,000 tons;

and North Africa, with 4,031,000,000 tons. The Pacific islands together furnish another 156,000,000 tons and Spain and Palestine 24,000,000 more. About five-eighths of these reserves are relatively high-grade phosphates, containing 58 or more per cent of tricalcium phosphate, commercially known as "bone phosphate of lime." The remainder is low-grade, containing less than 58 per cent of tricalcium phosphate. The deposits of the United States, North Africa, and the Pacific islands constitute the bulk of the high-grade rock, those of Russia and Siberia, the low-grade material.

The North African fields are the most favorably located with respect to present markets. Large reserves existing in the Western United States are remote from existing domestic markets and doubly so from foreign markets. The Pacific islands are distant from all markets, but they possess the advantage of containing the highest-grade rock. Whole cargoes of phosphate from Ocean Island are reported to contain as high as 88 per cent of tricalcium phosphate.

Potassium a Common Element

Potassium is one of the most common elements in the earth's crust. It is a constituent of many rocks, which are insoluble under ordinary conditions, but, fortunately for agriculture, it occurs also in considerable abundance in water-soluble salts at certain places in a form readily adapted for use in fertilizers. Since some of these salts are complex and all vary in purity, it is customary to sell them on the basis of the percentage of their contained potassium calculated in the form of potassium oxide, or K_2O. This chemical compound, which is purely theoretical, so far as these salts are concerned, is known to the trade as potash. Before the discovery of the great deposits of natural potash salts in Germany, about the middle of the last century, potash was obtained from organic sources, and small amounts of such material are still manufactured and sold. Some potash is also being made from silicates and other insoluble potash compounds. The great bulk of the world's production, however, now comes from natural salts, though these require more or less refinement to obtain merchantable grades.

The world's production of potash, K_2O, in 1924 was about 1,210,000 metric tons. Of this Germany supplied 73.85 per cent and France 22.40 per cent; the United States, 1.71 per cent, and Poland, 1.47 per cent. The remaining 1 per cent was scattered among four other countries. Under the present trade agreement between German and French producers the two groups are on a non-competitive basis, so that production and prices are as much subject to unified control as they were when the Alsatian deposits belonged to Germany. Such figures as are available for 1925 indicate a marked increase in production over 1924 and a somewhat greater predominance of the German and French production.

Potash Reserves

The world's reserves of potash in the form of soluble salts are estimated at about 2,338,000,000 metric tons of K_2O, sufficient at the present rate of production to last nearly 2,000 years. Germany has the largest reserves, amounting to about 2,000,000,000 tons. France is second with 300,000,000 tons, and the United States third with about 22,000,000 tons. Poland is estimated to have in the two mines at Kalusz and Stebnik about 20,000,000 metric tons of potash salts, equivalent perhaps to 5,000,000 tons of K_2O, and there is considerable unexplored territory believed to be underlain by workable beds of potash. Spain possesses potash beds similar in nature to those of Germany and France, the potash content of which is not yet fully determined, but it is estimated that the syncline at Suria contains 10,000,000 tons of K_2O. A small but interesting deposit estimated to contain about 1,250,000 tons has been found in Abyssinia, and other potash salts of unknown quantity are reported from the Salt Range of India.

German potash salts average about 10 per cent in K_2O, whereas the French deposits are somewhat higher, about 18 per cent. The German salts have the advantage of containing soluble sulphates and a greater variety of possible byproducts, whereas the French deposits are essentially chlorides of sodium and potassium. The Polish deposits are similar to the German, and are said to average about 25 per cent K_2O. Spanish deposits are reported to average about 20 per cent. United States production is practically all from the brines of Searles Lake, California. The potash produced here averages about 97 per cent potassium chloride and is the highest-grade salt offered to the fertilizer market.

There is much evidence that beds of soluble potash salts underlie vast areas in southwestern Texas and New Mexico and possibly in some of the Rocky Mountain states. Nothing definite can yet be said about their extent and thickness, but present indications are that they will prove to be a great reserve which may ultimately serve as the basis of commercial exploitation in the United States.

In addition to the salt deposits above enumerated, mention should be made of potash resources in the form of silicates, since some of these are now being worked in Italy and others in the United States give promise of being workable. Without going into detail it may be said that the leucites of Italy and Wyoming, the greensands of New Jersey, and mine tailings in Colorado have been estimated to contain together more than 9,000,000 metric tons of potash. These constitute an enormous reserve supply that may become available when improved processes of extraction are perfected.

Nitrate Deposits Mainly in Chile

The only known commercial deposits of nitrate of any consequence are those of Chile, found in the deserts of Atacama and Tarapaca, in the northern part of the country. The deposits are natural salts formed in the sedimentary rocks and gravels along the lower slopes of the mountains, and they contain 18 to 20 per cent of nitrates, which are recovered by leaching and precipitation. The United States and other countries have deposits of natural nitrate salts that are of scientific interest only. Some of these in the United States were utilized as sources of nitrate during the Civil War and others were intensively studied during the World War, but all have thus far proved inadequate for present commercial purposes.

The world production of nitrates in 1924, exclusive of byproduct and synthetic nitrogen in Germany, was 2,551,125 metric tons, of which Chile's share was 94.08 per cent. Synthetic nitrates from Norway constituted 5.52 per cent and the potassium nitrate of India 0.33 of 1 per cent.

The reserves of Chilean nitrate have been estimated at 245,300,000 metric tons for an explored area of 5,811 square kilometers, a quantity sufficient to last a hundred years at the present rate of production. But the unexplored area is about thirty-four times larger than the

examined ground, so that it is assumed that the available supply is probably considerably greater than the figure stated. The deposits are far from the world markets, but they are accessible to cheap ocean transportation and costs of production have been relatively low. In recent years byproduct and synthetic nitrogen has been coming into use in the fertilizer industry, thus supplanting to a certain extent the Chilean product. Nitrogen production from these sources is on the increase, so that its effects upon the Chilean industry will undoubtedly be far reaching.

Sulphur in Abundance

Native sulphur occurs in a variety of ways. In the craters of volcanoes, where sulphurous gases ascend through cracks, sulphur may be deposited through the reaction of these gases with each other or with air or water. A large deposit of this kind is worked at Hokkaido, Japan. Similar deposits occur in Mexico and Chile, and at White Island, near New Zealand, such a deposit is being reopened after the destruction of a previous plant at that site by volcanic eruption in 1914. More commonly sulphur is found at active or extinct hot springs in the tufas or other adjoining porous rocks like volcanic tuffs. Here it is formed by oxidation of hydrogen sulphide or by bacterial action. Such deposits are common in many of the Western states, and some of them have been worked.

The greater part of the native sulphur is not connected with volcanic processes, but is obtained from sedimentary beds in close association with gypsum and limestone. Such are the extensive deposits of Texas and Sicily, which now constitute the bulk of the world's production, and those of Louisiana, which were active until the latter part of 1924. The sulphur is derived from the gypsum through the reducing action of organic matter.

The world's production of sulphur in 1924 amounted to 1,856,950 metric tons, of which the United States produced 67.25 per cent; Italy, 17.20 per cent; and the United Kingdom, as a byproduct of coal distillation, 8.37 per cent. Of the six other countries listed as producing that year, only Spain, with 3.5 per cent, and Japan, with 2.45 per cent, deserve mention.

Sulphur Reserves

The world's reserves of sulphur range from about 56,000,000 to 121,000,000 metric tons, depending on whether more conservative or more liberal estimates are made. The two countries with the largest reserves are Italy and the United States. Italy on the more conservative basis is estimated to have reserves of 25,500,000 metric tons, and on the more liberal basis, 84,200,000 tons. The Texas-Louisiana field has been estimated to contain 30,000,000 tons of sulphur, with no allowance for new discoveries. Many other occurrences of sulphur in the United States are not included in these estimates, though some of them have been worked and others probably have commercial possibilities. The product of the Texas and Louisiana mines is sold as it comes from the wells on the basis of 99.5 per cent purity without further refinement. The sulphur rock of Italy, which is found mostly in Sicily, ranges in sulphur content from 10 to 25 per cent and has to be refined before marketing. No figures for Japan are available. Chile is reported to have in the provinces of Tacna and Antofagasta sulphur reserves amounting to 5,530,000 metric tons, with grades ranging from 70 to 96 per cent. Spain's reserves, as estimated, range from 525,000 to 1,750,000 metric tons. The grades range from 15 to 30 per cent. Although no figures are available, mention should also be made of the sulphur which is present in fumes generated at some of the great smelters in the United States and which is converted directly into sulphuric acid.

Pyrite as a Source of Sulphur

The pyritic ores include pyrite, marcasite, and pyrrhotite. Pyrite and marcasite contain when pure 53.3 per cent of sulphur and pyrrhotite contains 38.4 per cent. Marcasite is frequently found associated with coal and under conditions that indicate its formation under ordinary or moderate temperatures. The other two minerals are mainly products of high or intermediate temperature and are associated with rocks that were formerly molten or that have been changed under conditions of heat and pressure within the earth's crust.

The world's production of pyrite in 1924 amounted to about 4,674,000 metric tons, of which Spain contributed 48.11 per cent, Italy 11.22 per cent, and Norway, 8.77 per cent. Remaining production was presumably divided among twenty countries, though figures are not available for seven of them and none of them appears to have produced as much as 5 per cent. Japan, Germany (1923 figures), Portugal, France, and the United States all produced more than 3.5 per cent.

The world's reserves of pyrite are estimated to range from 183,000,000 to 423,000,000 metric tons. The most extensive reserves are those in the Province of Huelva, Spain, estimated to contain 132,000,000 to 264,000,000 metric tons. Russia, including the Urals, Siberia, and the Caucasus, is next, with 17,300,000 to 62,000,000 tons, and Norway third, with 3,000,000 to 35,000,000 tons. Then follow Germany, 10,000,000 to 21,000,000 tons; Portugal, 6,000,000 to 12,000,000 tons; Italy, 2,000,000 to 11,000,000 tons; Sweden, 5,000,000 to 7,000,000 tons; and France, 4,000,000 to 5,000,000 tons. Several other countries have smaller amounts. No estimates are available for the pyritic deposits of the United States, though these are known to be abundant. In 1924, production was reported from five states—California, Virginia, New York, Ohio, and Wisconsin.

The predominance of the Spanish pyrites, with 48 to 50 per cent sulphur, is evident from either the standpoint of production or of reserves. These ores are readily accessible to cheap transportation and have been mined since the days of the Phoenicians. The Russian reserves, which seem to range from 40 to 50 per cent, are less accessible for world trade, but some of the ores from the Urals are conveniently located with respect to the development of a superphosphate industry that utilizes Russian phosphates. The other deposits cited are all relatively accessible and the grades range from about 30 per cent to 52 per cent.

The following table summarizes the estimated reserves of the fertilizer minerals for all countries of the world for which figures are available:

World Reserves of the Fertilizer Minerals

	Metric Tons
Phosphates	16,877,000,000
Potash	2,338,000,000
Nitrates	245,300,000
Sulphur	56,000,000
Pyrites	183,000,000
Total	19,648,000,000

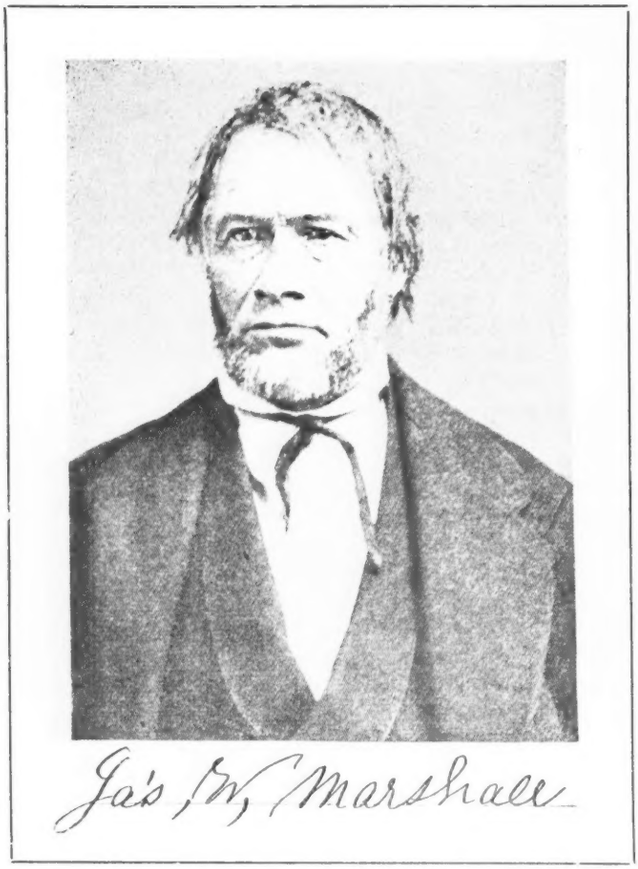
The world's production of fertilizer minerals in 1924, as stated on a preceding page, was about 18,000,000

metric tons. The table indicates that the estimated reserves amount to about 19,648,000,000 tons. If the more liberal estimates for sulphur and pyrites are used, the total would be about 20,000,000,000 tons. In either case the estimated amounts would be sufficient to supply the world for more than 1,000 years at the present rate of consumption. The phosphates, sulphur, and pyrites are widely enough distributed so that no nation need fear privation through temporary exclusion from some source of supply. Natural nitrates are localized in Chile, but these are susceptible to replacement by nitrogen from byproduct or synthetic sources. Potash salts are largely localized in Germany and France, but moderate reserves are now available among other nations. The recent discoveries of potash in Texas and elsewhere in the United States and the development of processes for the extraction of byproduct potash, some of which are well advanced, lead to the expectation that the available reserves of potash outside the two nations named will eventually be greatly increased.

James W. Marshall, Discoverer of Gold in California

By Burr Evans
San Francisco, Calif.

JAMES W. MARSHALL, discoverer of gold at Sutter's mill, in California, Jan. 19, 1848, was born in New Jersey in 1812. From there he migrated to Oregon and thence to California. He died Aug. 10, 1885, at the age of seventy-three, at the old mining camp of Kelsey, about four miles east of Coloma, Calif. The accompanying picture is a copy of a copyrighted daguerreotype taken of Marshall at the age of fifty-two years. He was always averse to publicity and especially to being photographed. The manner in which the picture was obtained was as follows:



Judge William Carpender (my brother-in-law and an early-day miner of Smith Flat) was a friend and partner of Marshall for many years. He knew his aversion to having his picture taken, and had tried many times to get Marshall to sit for his picture. In this he always failed.

Marshall, like many of the old-time gold miners, would make a trip from the mountain mining camp to Sacramento whenever the need and the mood happened to come together. And, as was the usual custom with many of the miners, he would get on a drunk for several days and often go broke. One morning in the middle of the 60's Carpender met Marshall on Jay St., in Sacramento, strictly sober and flat broke, just surviving from a three days' round of joy, and so dry that he had to get a drink in some manner. After greeting his old-time friend, Judge Carpender, he made it known that his dryness was beyond control, and requested a temporary loan of "four bits."

The meeting happened to be in front of the new daguerreotype (tin-type) shop, and Carpender perceived it was an opportune time to obtain the long-sought picture. With a half dollar in his hand as a tempting inducement, he told Marshall to step into the photo-shop and have his picture "took," and the half dollar would be his. Marshall declined, but after Carpender said "All right" and started up the street, Marshall called him back and consented to have his picture taken and also to write his signature in order to obtain the wherewith to quench his overpowering thirst.

It will be noted in the photograph that Marshall's hair is not combed and that his tie is awry. His eye is bright, however, with a definite gaze, and his mouth, which, by the way, is somewhat like that of Abraham Lincoln, is firm. So far as is known, this is the only picture Marshall ever had taken. Albert B. Carpender, a son of the Judge, had the picture copyrighted and has given his permission for the *E. & M. J.* to publish it "for the good and benefit of the ancient and honorable industry of mining." An enlarged copy was presented, by Mr. Carpender, to the Smithsonian Institution, Washington, D. C.

Bwana M'Kubwa an Open-Cut Mine

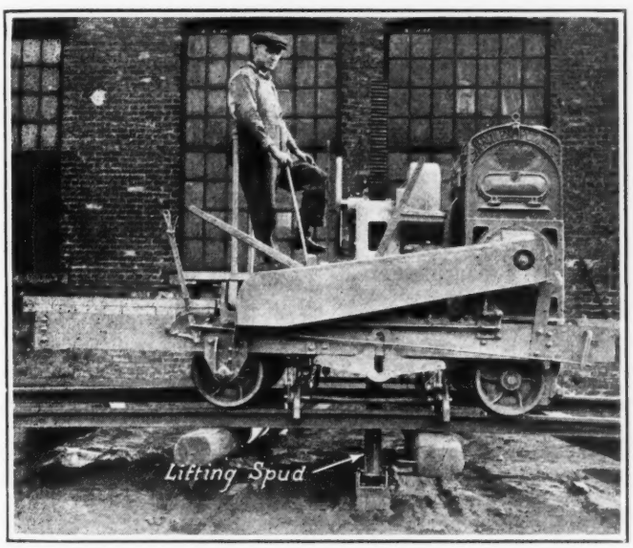
The Bwana M'Kubwa mine is in good condition, according to a report in the *S. A. Mining and Engineering Journal* Year Book for 1927. The width of the copper-bearing formation is sufficiently great to make possible the operation of the mine by steam-shovel methods, which indicates low working costs. While the plant is being erected, the steam shovels have been busy, and at present 200,000 tons of copper ore are on the dumps, which have been established close to the reduction plant. Stripping of the overburden on the hanging-wall side of the orebodies has made good progress, and by the time the plant is running, says the report, it is expected that two and a half years' supply of ore will be uncovered and available for the steam shovels.

Useful Operating Ideas

Track-Shifting Machine

By Gail Martin
Salt Lake City, Utah

Operators who are compelled to shift or raise railroad track frequently find the recently perfected Nordberg track shifter extremely serviceable. For building



Track-shifting machine in operation

dumps, making fills, for railroad construction, and ballast work where the track must be raised vertically, as well as for use in open-pit mines, quarries, waste dumps, or behind steam shovels, the track shifter is being used with excellent result. At the Utah Copper mine, at Bingham, Utah, two track shifters, each manned by one operator and three helpers, are doing the same work that formerly required eighty men. Results at Chino, Nevada Copper, United Verde, and Inspiration are as satisfactory.

The track shifter raises or moves track without the use of track jacks or aligning bars. In dry, loose material such as sand, cinders, and slag, or under wet, muddy conditions where it is difficult or impossible to move track with jacks, this machine works with ease. It is estimated that the track shifter will move two to four times more track than can be done by twenty men.

The machine consists of a steel-frame car on which is mounted a worm-driven lifting spud and a 40-hp. four-cylinder fully-inclosed motor. The frame of the car is made of heavy steel channels securely riveted together. At one end is a large platform for taking men and necessary tools to the job. The bronzed gear and hardened steel worm for supplying power to the spud are of ample proportions to assure long life and minimum wear. Parts are completely inclosed and run in a bath of oil.

In operating, the machine is first clamped to the rails by the clamp lever at its side. The spud is then racked down with the footpiece, set between the ties, and tilted in the direction the track is to be shifted. When the footpiece reaches a solid footing, power is applied to the spud, which lifts the rails and ties free from the embedded position. Since the spud is set off center, one rail is lifted higher than the other. As the lift increases, the load becomes so heavy on the tilted spud that the entire track section and the machine clamped to it gently slide over. The machine is then propelled ahead and the process repeated until all the track is shifted.

For raising track and ballasting, the machine is equipped with a leveling device, which can be attached to any standard machine. Rough ballasting can be done with the standard machine, but it is difficult to raise the track level with the single spud.

A recent innovation is the addition of a mast, boom, and hoist to the standard track shifter, making a railroad track-laying machine. The hoist is operated by the engine on the track shifter, which makes this machine applicable for maintenance work.

Blasting Stuck Ore Passes and Transfers

In Serial 2790, U. S. Bureau of Mines, E. D. Gardner discusses the problem of the hung-up ore pass and ore transfer. Where a manway is alongside, punching with a bar through small holes in an ore-pass lining is one effective method of overcoming the difficulty. Another is the shaking of a chain which is left hanging in the ore pass or transfer. Where no accessory manway is available, water is sometimes run into the top of the transfer or ore pass. However, the usual method under such circumstances is to explode a bundle of sticks of dynamite, called by miners a "bomb," attached to a lath and placed under the obstruction. From two to seven cartridges are tied together. In Arizona gelatin and ammonia dynamite in 30, 35, 40, and 60 per cent strengths are used for this purpose. Miami Copper Co. uses 30 per cent gelatin dynamite when blasting near timber. The cartridges are 1¼ by 8 in.

In making up the bomb, the cartridges are placed side by side and tied together near one end by stout twine wrapped around them two or three times and tied with a square knot. After tying the bundle, the middle cartridge is made into a primer by inserting a blasting cap with attached fuse in the end of the cartridge. The pointed end of the stick (1 by 1 in. by 10 ft. long, Douglas fir) is pushed under the string and between two of the cartridges of the bundle. Then the other end of the bundle is tied to the stick with a second piece of string.

The bomb is introduced through the chute gate and pushed up the ore pass, additional blasting sticks up to the number of five or six being spliced together, either by nailing or by tying, where necessary. When nailing is resorted to, flat blasting sticks are required, as the 1 by 1-in. sticks split when nailed. A high-power flash lamp is used for inspecting the hang-up and to furnish light when placing the bomb.

Fuse and blasting caps are used to detonate the bomb at most mines. Fuse in 6 to 8-ft. lengths is necessary where blasting sticks are spliced. The Miami Copper

Co. now uses electric blasting caps with 10-ft. lead wires. Inexpensive cotton-insulated, double-lead, copper wire connects the leads to the blasting line on the haulage level, which is 50 ft. in length and consists of a two-strand, rubber-insulated wire. A small blasting machine supplies current.

When the charge is detonated, the blasting line is given a quick jerk and as much wire as possible is pulled out of the ore pass ahead of the falling ore. With electric blasting more time can be taken to insure the proper placing of the bomb, and safe conditions rule both before and after detonation. Excessive smoke, which is principally derived from the fuse, is also avoided by electric blasting.

Hang-ups in finger transfers or drawing raises can be started only by blasting. This work of blasting is done during the shift, thus increasing the hazard. From the grizzly level in undercut caving inclined transfers extend to a square set above, from the four sides of which extend short drawing fingers. Regular crews of chute blasters, consisting of two men, go from drift to drift on the grizzly level and blast the hanging finger raises. The practice is as already given. At most mines fuse in 2-ft. lengths and No. 6 blasting caps are used for detonating the bombs. Where the obstruction is close to the gate in the square set, the bomb is placed in position by hand. When it is above this position the charge is placed in position by means of the blasting stick.

Many accidents have occurred in following the foregoing practice. Bombs have fallen or have been knocked from the blasting stick down the raise and have exploded upon the grizzly level. Also, bombs have dropped through the grizzlies to the haulage level below before exploding, and men have been fatally injured from this cause. Explosive cannot be placed to the best advantage when it contains a lighted fuse only 2 ft. in length. Electric blasting is safer, as the charge can be exploded at will. At the Miami mine all hang-ups are blasted with bombs exploded by electric blasting caps. A No. 8 electric blasting cap is used.

The following safety rules are given by Gardner:

1. All blasts in "hanging" chutes, ore passes, or drawing raises should be fired by means of electric detonators whenever practicable.

2. When it is not practicable to blast a "hanging" chute electrically, the fuse used for chute blasting should be at least 2½ ft. long. When blasting sticks must be spliced, 8-ft. fuse should be used.

3. Everyone should retire to a safe distance while blasting is being done.

4. Chute blasters should keep explosives in a bag provided for that purpose. Detonators should never be placed in the same container as explosives. Blasters should always take the explosive and detonators with them when they go from one drift to another.

5. In blasting a hanging chute, the bombs should be securely fastened to the blasting stick.

6. Chute blasters should not blast more than one chute at a time.

7. Chute blasters should use extreme care in guarding the approaches to the chutes they are about to blast.

8. When chutes or raises are being blasted, warning should be given on the level below by means of bells or other suitable signals.

9. The blasting of chutes on haulage levels should be done by the boss in charge of the train crews, or directly under his supervision. Men on the grizzly levels should be warned before any hanging chutes below them are blasted.

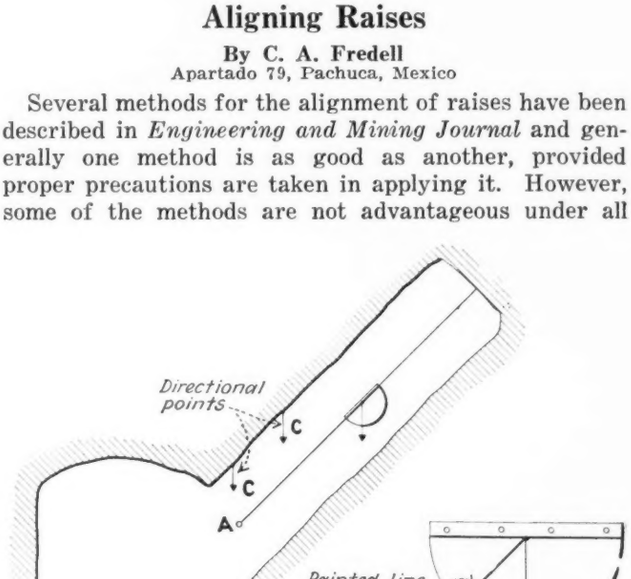
10. Chute blasters should be able to speak English. If a large percentage of the workmen speak a foreign language, the chute blaster should be able to speak that language also.

11. When electric blasting is done from the mine power circuit instead of from blasting batteries, it is important that the current be held in the blasting lines but a fraction of a second; otherwise there is danger from fire due to short-circuiting and overheating of wires in contact with broken timber.

Aligning Raises

By C. A. Fredell
Apartado 79, Pachuca, Mexico

Several methods for the alignment of raises have been described in *Engineering and Mining Journal* and generally one method is as good as another, provided proper precautions are taken in applying it. However, some of the methods are not advantageous under all conditions, more especially where the raise is a single compartment and untimbered. The following method, on the other hand, has been successfully used under varying conditions, and has been found to be suitable for single-compartment raises where sighting boards are likely to be knocked out:



A simple method of aligning a raise

Having determined the inclination of the raise, the angle is laid out upon a clinometer constructed of sheet tin as shown in the accompanying figure. The clinometer is provided with a stout cord which passes through several holes in the base line of the clinometer. A hole 12 to 16 in. in depth is drilled into the side of the raise at the mid-point between footwall and hanging wall, as at *A* in the figure. By tying one end of the cord to a drill steel or tamping stick placed in the hole and carrying the other end of the cord to the face of the raise, the approximate center line is quickly ascertained by raising or lowering the cord until the plumb bob hangs directly over the painted line at *B*.

In a long raise the point *A* is advanced every 50 to 60 ft. The inclination of the raise can be changed at any of these points by removing the painted line and placing a new line upon the clinometer. Direction points are set in plugs in the hanging as at *CC* in the figure.

Discussion

Ancient Copper Smelting

THE EDITOR:

Sir—In criticism of my article, "Ancient Copper Mining and Smelting in Central Africa," (*E. & M. J.-P.*, Nov. 21, 1925) T. A. Rickard has written (*E. & M. J.*, Jan. 8, 1927):

"Mr. Walker's reference to the statement in 'Purchase's Pilgrimes' is to the point, but after discussing the matter with Messrs. F. E. Studt and Robert Williams recently in London, I think it safe to assert that the copper exported at the beginning of the seventeenth century from Bangweolo must have come, not from Katanga but from Bembe, in northern Angola, where copper in the form of malachite has been worked for more than a century, and probably as much as two hundred years ago. I know of no evidence to justify any higher antiquity for copper mining in Central Africa."

Bangweolo is not a port, but an inland lake. It is 1,300 miles east of Bembe and 150 miles east of the Katanga mines. Bembe is some 400 miles north of Benguella (the port named in "Purchase's Pilgrimes," but changed to Bangweolo by Rickard), about 100 miles from the equally old port of Loanda and a much shorter distance from Ambriz, the port from which Bembe copper undoubtedly always was shipped.

"Purchase's Pilgrimes" was first published in 1625. It tells of an English sailor held prisoner at Benguella at some earlier date having seen slaves coming down from the farthest interior bringing copper. That was over 300 years ago, not 200, as Mr. Rickard assumes, so here is 100 years that he overlooked. Export copper from Katanga would have gone either to Benguella or Zanzibar, those being the west and east ports, respectively, of the ages-old ivory and slave trail across Central Africa. That trail crossed the Musoni mine, of which Mr. Rickard writes. Arnot saw and described it forty-four years ago. It is not a recent discovery.

J. J. Monteiro, "an Englishman with a Portuguese name," who mined copper at various places in Angola some seventy years ago, was at Bembe during 1858-59. In his book, "Angola and the River Congo," published over fifty years ago, he states that large quantities of the malachite at Bembe had been mined before the country was taken possession of by the Portuguese, which, incidentally, was about 350 years ago.

Notwithstanding "Purchase's Pilgrimes," Monteiro and other evidence, Mr. Rickard writes: "The so-called ancient workings therefore are unlikely to be more than a hundred or a hundred and fifty years old." I shall not argue with him that copper shipped over 300 years ago must have come from ores mined over 150 years ago.

That the Arabs did mine some copper at Katanga is well known. The theory that they introduced copper smelting was discussed and abandoned years ago. Few ever believed it. Mr. Rickard thinks they did, and then largely discontinued it twenty-five to seventy-five years later. Let us see how the facts square with this theory.

Several hundred separate copper ore deposits scattered over an area larger than the United States were worked, many of them extensively, in prehistoric times. They are found near the Cape, in the Transvaal, in the Rhodesias, in Portuguese East Africa, in Angola, in the Sudan, and elsewhere over an area roughly 2,500 miles long and 2,000 miles wide. If the Arabs conducted all those operations as recently as Mr. Rickard assumes, is it not more than passing strange that the intelligent leader of all of them in Central Africa was unable to tell Livingstone or Stanley whether the Lualaba River was the Congo or the Nile, or where it entered the ocean? That the Arabs could have found and worked all of these widely separated copper deposits in 100 or 1,000 years in savage, war-cursed, man-eating lion-infested interior Africa where neither wheeled vehicles nor beasts of burden were used would not be believed by a child in any history class. Why, it was over 180 years after the landing of the Pilgrims when the first overland journey to the Pacific coast was made by Lewis and Clark! And there were horses in America and no tsetse flies to kill them.

In writing of Katanga that "The old mines of the eastern district consist of holes 90 to 125 ft. wide and from 20 to 25 ft. deep," Mr. Rickard has been misinformed. At the Kipushi (now Prince Leopold) mine the excavation, oval in shape, is 600 ft. across and estimated to be 200 ft. deep, though accurate measurement of depth is prevented by silt. As there is no waste dump anywhere around this pit, it must be assumed that only ore fit to smelt (25 per cent copper) was mined from it, and as workings recently driven under it encountered massive chalcocite running 60 per cent, this assumption seems well founded. That pit apparently yielded 3,000,000 tons of ore containing 750,000 tons of copper.

At the Star-of-the-Congo was an ancient pit three-quarters of a mile long and 600 to 1,000 ft. wide, or large enough to compare with some of the steam-shovel pits of the western United States. Several others are many acres in extent. In at least one mine at Katanga the ancient workings were encountered in a level 90 ft. deep. At the Alaska mine of Southern Rhodesia Base Metals, workings ancient enough so that there is no local legend concerning them cover some six acres, and having recently been encountered in a drift at the 80 ft. level they are known to go deeper than that. If I were not limited as to space others could be described.

There is abundant evidence that far more copper was mined prehistorically in Africa than in all the rest of the world. The ancient copper workers there probably moved a much greater footage of rock than was built into the architecture of ancient Egyptians, Mayas, Incas, and most of the other erections which are considered the wonders of the world. It stands to reason, therefore, that the art of smelting copper originated in Africa, and that it has been practiced there for thousands of years. Those who have studied the subject on the ground, the many I have interviewed at least, believe that copper smelting dates back to great antiquity.

Dr. David Livingstone, a careful observer and never given to exaggeration, became satisfied—Mr. Rickard

quotes him—that ingots had been cast from Katanga copper "from time immemorial." P. K. Horner (Mr. Rickard describes him as "an English mining engineer," evidently not having learned that Mr. Horner was born in Missouri, or that he was for many years general manager of Union Minière du Haut-Katanga) has had an extremely wide experience in African copper mining and exploration, and it is his opinion that the natives of Africa have been smelting copper for at least 2,000 years.

Copper in cast, hammered, and drawn shapes is being dug up wherever excavations are made throughout the vast area I have described, these finds telling of the losses by natives, due to the softening of the ground during the rainy seasons, over countless past ages. For many miles along the Kafue River, immediately south of Katanga, the bank is lined with copper slags, and nuggets of the metal coming from the decomposition of these slags may be washed out of the river gravel like gold out of a placer.

There is evidence of invasions of Africa by several other peoples prior to the coming of the Arabs. Some of those peoples may have introduced copper smelting, but it is more probable that all of them learned it from the Africans. Ancient Egyptian influence may be noted today extending entirely across the continent to Nigeria.

Sufficient interest in the antiquity of copper smelting in Africa should be aroused to cause those who are working mines there to measure and study the ancient workings with the greatest possible care.

London, England. GEORGE L. WALKER.

Classification Efficiencies

THE EDITOR:

Sir—In the report of the annual meeting of the A.I.M.E. which was published recently in your periodical, I note certain comments made by Prof. Arthur F. Taggart, of Columbia University, on the data presented by W. L. Remick and myself in a paper entitled "Recent Advances in Classification."

Professor Taggart is reported as stating his belief that the data concerning the Dorr classifier were obtained by students and therefore were not trustworthy. The data in question were obtained after three days' preparation, and in the course of an afternoon's run, under Professor Taggart's and my own supervision, by the senior students in chemical engineering. The reliability of the data thus obtained is therefore fully as great as that of data obtained by any competent man assisted by the usual mechanics or laboratory assistants which are called upon to do such work.

Professor Taggart, further, intimates that the efficiency of the classifier would increase with increase in sand load. This, however, is not the case in the test on which a report was made. With an increase in the circulating load of from 5,700 lb. per hour to 14,400 lb. per hour—that is, an increase from what Professor Taggart considers to be 30 per cent of the capacity of the classifier to 80 per cent—the efficiency did not increase but decreased slightly.

It is believed that the reason for the discrepancy between the efficiency obtained in the test reported on and the figures quoted from practice by Professor Taggart is probably due to the distribution of the rock particles into different sizes in the several cases at hand. Manhattan schist breaks in preference in the vicinity of 65 mesh—that is, there are proportionately many more particles of that size than there are in most crushed rocks. Therefore, the classifier that operates on Manhattan schist has a much harder task than one operating on ground quartz, because it has to make a separation among particles of very nearly the same size. This, of course, applies to the Hydrotator as well as to the Dorr classifier. A. M. GAUDIN.

University of Utah, Salt Lake City.

The Mint-Ruby Silver Prospect

THE EDITOR:

Sir—In the Feb. 12 issue I note an article about mining in Alaska on page 298, which is incorrect.

W. F. Deaner took the Mint group of claims and the Mint Extension on a lease and is contemplating starting mining on June 1, 1927, but the situation of the mine is about three miles up on Portage Creek, which empties into the Susitna River, and about nine miles from Chulitna Station, and not Susitna, as the latter is 125 miles from here.

Your correspondent has gotten the new find made last year mixed up with the Mint Ruby silver prospect. The Ruby Silver has more merit than this would indicate. Assays on the Ruby Silver lode do not show any zinc or molybdenum. The new find is about 1¼ miles east of the Ruby Silver lode and is on the west wall of an intrusion on which there has been practically no work done to determine the value of the deposit.

I also note he says that arrangements are being made to install a mill. Such is not the case. Arrangements are being made to sink 200 ft. on the Mint group and to drift on the lode to determine its value. If the value of the ore holds out in depth, then and only then will the mill be installed.

Being one of the owners of the Mint Ruby silver prospect, and the one that made the new discovery last August, accompanied by George S. Moshier and Moose Johnson, I know what the situation is.

Chulitna, Alaska. HARRY A. WERTZ.

Oil Shale in Esthonia

THE EDITOR:

Sir—In your editorial on "Oil Shale in Esthonia" in the *Engineering and Mining Journal* of Feb. 19, 1927, you state that "the Republic of Esthonia, concerning whose exact location and boundaries most of our readers are probably somewhat vague, appears to be the most striking practical exponent of shale oil." A profit of 15,000,000 Esthonian marks in 1925 is mentioned. It is submitted that the meaning of this figure might also be somewhat vague to many of your readers; $39,500, the approximate equivalent of 15,000,000 Esthonian marks at the end of 1925, might convey more.

When speaking of a practical exponent of an industry, it seems worth mentioning that the oil-shale properties in question were confiscated by the Esthonian Government without compensation to their rightful owners. If acquired by similar methods many an enterprise might become a most striking practical exponent of an industry.

You state that the Esthonian oil-shale industry is a state monopoly. There were, however, at least two private companies engaged in the mining of oil shale in Esthonia in 1925. H. A. KURSELL.

Wallace, Idaho.

Ores of the Joplin Region

THE EDITOR:

Sir—Your article on "Ores of the Joplin Region," in the *Engineering and Mining Journal* of Jan. 29, 1927, is extremely interesting and presents an unusual grasp of the problem. There are, however, some geological conditions in the field which it seems to me do not agree with your theory.

You suggest a single "gush" from an underlying hypothetical magma to account for the bringing in of several hundred million tons of ore scattered through an area of about 800 square miles. It would be interesting to have your idea as to the character and composition of this "gush." In your former writings I understand you to state that ore magmas are viscous and that when they are so diluted that they appear as thermal springs, the only metals deposited are quicksilver and antimony. Certainly you state that lead and zinc ores are not formed by ascending thermal solutions. Yet in your article on "Ores of the Joplin Region" you speak of the zinc and lead ores being deposited by "solutions," not magmas, and if these solutions were not moving, how could they possibly contain enough metal to cause the ore deposits? If they were not largely and predominately aqueous, what was the solvent which entered into their composition to such a large degree as to make them mobile? That the solutions were aqueous, and were in fact extremely similar, if not identical, with those of thermal springs, seems to me a clear corollary to your statements. Therefore, according to my understanding of your former writings, the zinc and lead could not have been deposited by the hypothetical solutions described in your article.

To date no channels in the country rock surrounding the orebodies which show alterations by hot magmatic solutions have been found. There is practically no mineralization outside of the flint or dolomite areas, and certainly, if channels exist, it is reasonable to assume that they would have been found by the hundreds of miles of underground workings and thousands of drill holes. The records show that drill holes, if drilled deep enough, always go into tight unmineralized, unaltered, interbedded limestone and flint, under all orebodies; and also mineralized areas are in every case surrounded by unfractured, unmineralized, unaltered, interbedded limestone and flint. If this is so, how could the hot magmatic solutions have reached the points where the ores were deposited without altering the limestone either below or around the mineralized areas?

Studies of four hundred thin sections of ores from the Joplin region show that the order of deposition of the primary ore minerals is: 1, dolomite; 2, chalcopyrite; 3, galena; 4, sphalerite; 5, galena; 6, chalcopyrite; 7, marcasite; 8, pyrite; 9, calcite; 10, barite; 11, marcasite. The marcasite is found in the deepest workings of this district and occurs with all of the lead and zinc ores. Is it not difficult to account for the zinc being deposited by hot magmatic solutions and the marcasite by cold solutions?

There are many indications that replacement and cavity filling by primary ore minerals were going on at the time mining began, such as galena on the surface of sphalerite crystals and along some of its cleavage planes; small fresh crystals of sphalerite disseminated in black mud and stalactitic forms of galena, zinc sulphide, and iron sulphide. Obviously, none of these recent deposits can be magmatic. If, then, the sulphides can be deposited today from underground solutions, why may not the older deposits have been formed in the same way?

Microscopic crinoid disks and, once in a great while, an occurrence of stylolites, are found preserved in the jasperoid. Is this not strong evidence that the jasperoid was formed by the replacement of limestone by cold meteoric solutions and not by hot magmatic solutions?

You state that the ores are banked "under the Cherokee shale." It is true, in exceptional cases, where the shale has caved in because underlying beds have been removed by solutions, that there is ore in and immediately below the shale, but the total production from the Boone-Cherokee contact is negligible compared with the other producing horizons. In the Picher district the general positions of the orebodies are distinctly below the Cherokee shale-Boone contact. The Boone formation as a whole under the normal shale is rarely mineralized or altered in any manner.

If the ores were deposited by meteoric waters and artesian circulation, there would be mineralization only a limited distance under the edge of the Cherokee shale. This appears to be a fact, as is shown by several hundred holes recently drilled by the St. Joseph Lead Co. and the Grasselli Chemical Co., which indicate that beyond an irregular zone located west of the Cherokee-Boone outcrop there are no traces of zinc, lead, jasperoid, or dolomite in fractured or unfractured areas. East of the same zone traces at least of the ore minerals are generally found in drill holes. If the ores came from a magma, why would they be limited to the areas of artesian circulation?

Dr. C. E. Siebenthal, in his report in U. S. Geological Survey Bulletin 606, offers a logical theory for the deposition of the ores from meteoric waters. The presence of hydrogen sulphide in the waters of the district seems ample to account for the transportation and deposition of the galena, blende, and other sulphides.

In the short space of a letter it is impossible to go into any comprehensive discussion, as the relation of the orebodies to subnormal shale alone would require many maps and many pages of description, but above I have endeavored to indicate some of your observations and theories which I cannot reconcile with the actual geological conditions in the Joplin district.

Although I personally am unable to agree with your conclusions, I feel that the district is indebted to you for your analysis of our problems. It will undoubtedly have a marked effect in the future on the attention given to facts that have a bearing on the origin of the ore deposits. Perhaps we shall have sufficient data to reach an agreement before the ores are exhausted and the mines abandoned.

FOSTER S. NAETHING.

Joplin, Mo.

His Complaint

The Editor:

Sir—I have been a constant subscriber for nearly forty years—since 1888, to be exact—except for some few intermittent years when my earnings were insufficient. I have one complaint to make—you steadily improve more or less, in each number.

If you wish to publish this letter I have no objection.

El Paso, Tex. W. H. SEAMON.

Consultation

"Tequesquite" and "Tizate"

"According to the Law of Mineral Industries of Mexico, certain things are not subject to concession for mining exploration. Among these are 'saline lands not directly formed by the action of sea water, the "tequesquite" and the "tizate."' Can you define the last two terms?"

Juan de Dios Villarello, who is in charge of the Geological Institute of Mexico City, has supplied the following definitions:

"'Tequesquite' is the name given in Mexico to all natural sodium carbonates. It is a corruption of the Mexican word 'tequesquitl,' composed of 'tetl,' stone, and 'quixquitl,' to effloresce, to spring; that is, 'efflorescent stone.'

"'Tequesquite' is found in amorphous, crystalline, or pulverulent form. Its color varies from almost pure white to yellowish, grayish, or brownish and honey-colored. In its amorphous condition, as is generally found in saline deposits, it is lusterless and of cluster-like and lamellar structure. Hardness is from 2.5 to 3. Crystals are monoclinic, white-yellowish, of vitreous luster, and efflorescent. The taste is alkaline.

"'Tequesquite' corresponds to the mineral called 'trona,' its chemical composition being $3Na_2O.4CO_2.5H_2O$, theoretically containing 38.9 per cent carbon dioxide, 41.2 per cent soda, and 19.9 per cent water.

"Industrially considered, 'tequesquite' is composed of a mixture of sodium sesquicarbonate and sodium chloride, with small quantities of sodium sulphate, potassium chloride, and sometimes nitrates of sodium and potassium. In the purest "tequesquite' the contents of sodium sesquicarbonates vary from 70 to 79 per cent, the sodium chloride content is from 15 to 39.3 per cent; sodium sulphate, from 1.5 to 3 per cent, and potassium chloride, from 0.40 to 1.5 per cent; the best contains not over 37 per cent of soda. The impurities are generally clay, fine sand, and organic matter.

"The 'tequesquite' deposits in some localities are named after the general look of the saline efflorescence, depending on the condition in which they were formed and the degree of pureness. So, at Texcoco, the white, efflorescent 'tequesquite' found in botryoidal aggregates or masses, giving it the appearance of a cauliflower, is called 'confitillo'; the one found in scaly forms is called 'cascarilla' or 'tepelcatillo'; the one taken from the foaming surface of impregnated waters is the 'espumilla'; the finely crystallized or pulverulent is called 'cristalillo' or 'polvillo'; and the impure variety, mixed with argillaceous earth and fine sand, is called 'tequesquite prieto.'

"'Tequesquite' is found in the following places in Mexico:

"State of Chihuahua: Ojo Caliente, Bravos district. Julimes and Santa Rosalía, Camargo district.

"State of Jalisco: Guadalajara district. Lagunas de la Cuenca de Sayula, and Zacoalco, Sayula district.

"Texcoco Lake, near the City of Mexico.

"'Tizate' corresponds to the mineral called 'tripolite,' an opal variety, also called 'tizar' diatomite, terra tripolitana, infusorial or diatomaceous earth, farina fossilis, and earthy opal. 'Tizate' and 'tizar' are of Mexican origin, 'tizatl' meaning white earth.

"The color of 'tizate' varies from pure white to yellowish, grayish, brown, and even black, according to impurities. The forms in which it occurs are fine powder, earthy looking, laminated and schistose; also in compact masses. Specific gravity ranges from 2.1 to 2.2, and is sometimes less than 1. It scratches glass, and when rubbed produces a peculiar noise. It is insoluble in acids, excepting hydrofluoric acid, and soluble in alkalies.

"'Tizate' is formed by the accumulation of siliceous remains of numerous microscopic organisms called diatoms, deposited in enormous quantities during different geologic epochs. Diatoms are unicellular plants of a great variety of forms and structures. They are distinguished by their siliceous skeletons. Frequently the diatom remains are found associated with detrital material. Their chemical composition is chiefly hydrated silica; according to the composition of the water in which they were formed; silicates of aluminum, sodium, iron, and other substances are also present, with phosphates of iron, calcium and magnesium.

"Various kinds of 'tizate' have been analyzed, with the following results: From 72.5 to 88.78 per cent silica; from 2.32 to 11.71 per cent alumina; up to 2.61 per cent lime; and magnesia, potash, and soda in minor quantities. The amount of water varies from 5 to 10 per cent. In its natural condition 'tizate' often contains from 25 to 40 per cent water, expelled when heated to 100 deg. C.

"'Tizate' is found in some localities of the Federal District of Mexico, and in the states of Aguascalientes, Durango, Guanajuato, Hidalgo, Jalisco, México, Michoacán, Oaxaca, Puebla, and Querétaro."

Inclination of a Mine Shaft

"There seems to be a difference of opinion among mining men in the designation of the angle of a shaft, and we are writing to you to ask if there is any definitely accepted definition regarding the angle of a mine shaft which can be taken as a standard. For illustration: A party writes asking for information on a 70-deg. incline shaft. Some mining men mean by this that the shaft is 70 deg. from the horizontal or 20 deg. from the vertical. Others mean that the shaft is 70 deg. from the vertical and 20 deg. from the horizontal. Would you please advise us if there is any accepted standard in regard to the interpretation of these angles."

Though we do not know that there is any universally established rule in the matter, we feel sure that nine people out of ten stating that they had a 70-deg. inclined shaft would mean that the shaft was almost vertical. In other words, the degree of inclination is measured from the horizontal rather than from the vertical. You will observe that this agrees with the accepted method of stating the dip of a formation; and as shafts frequently are run parallel to the dip, the agreement in terms seems logical.

Sources of Osmium

"I should like to know the source of osmium. How does it occur and what is the method of treating the ores?"

Osmium is found in association with the other metals of the platinum group. One native alloy, osmiridium, is used in its natural state for pointing gold pens. So-called crude platinum is the principal source of palladium, iridium, and osmium. The principal sources of platinum metals at the present time are Colombia, Russia, Canada, and the United States in the order named, with the first two by far the most important.

As to the recovery of the metal and the treatment of the ore, the first step is usually one of mechanical concentration, the deposits being either lode or placer. The metal is recovered from the concentrates by a treatment based on the solution of the metals in aqua regia and recovery as double ammonium chlorides.

News of the Week

Summary

ANOTHER WEEK has passed with the boom at Weepah, Nev., still resounding. Nothing so far has been done to spoil the fun and it is problematical how long the excitement will last if the discoverers of the high-grade find continue to restrain themselves from pulling another round.

Another mill, that of the Tar Creek Mining Co., has recently been destroyed by fire in the Tri-State district. The frequency with which fires happen in this section should be considered in connection with the fact that the number of concentrators is abnormally large, over 200 in fact.

Silverton, in southwestern Colorado, will shortly resume communication with the outer world, it is reported, after having been hemmed in by snow slides and drifts for about a month.

An interesting bit of news states that the old Congress mine in Arizona is to be reopened by a syndicate. This is the deepest gold mine in the state.

The foreign news letters of the week are interesting, that from Mexico City in particular. In Jalisco, the miners' union at Cinco Minas is demanding a six-hour working day and more or less enforcing it by stopping work when the six hours are up. From Melbourne comes word that the Great Boulder Proprietary and the Golden Horseshoe mines, in the Kalgoorlie field, will merge. The graphite deposits known to exist in South Australia and Western Australia contain a considerable tonnage of ore in sight, worth about $850,000.

In Northern Ontario and Quebec, prospects of colder weather have encouraged operators who still have equipment to move.

Fast Driving at the Europa Mine

Ordinary Methods Used—Mucking by Hand Labor—Work Compared with That at Tintic Standard

By Walter Neal

U. S. Smelting Exploration, Parral, Chih., Mexico

AN UNUSUAL RECORD for fast driving was recently established by the U. S. Smelting Exploration, S. A., at the Europa mine, in the Parral district, Chihuahua. The results obtained and the methods employed present an interesting comparison with those described by Gail Martin in your issue of Feb. 26. Mr. Martin concedes to mechanical equipment the larger share of credit for the excellent results obtained by the Tintic Standard, but in view of the work accomplished with the good, old-fashioned muckstick at Parral, the fraternity must look to the manufacturers for still further improvements before throwing all the shovels over the dump.

The contractor on the job was James Page and the superintendent in charge, J. W. Shotwell, and during the four-week period terminating Nov. 4, 1926, they made the following advances in a crosscut:

	Feet
	169.90
	181.71
	210.58
	205.33
Total	767.52

The average per week was 191.88 ft.

During the week of maximum progress work was carried on for six days of three shifts and one shift on Sunday. Sunday work was avoided as far as possible, but movement of material and minor repairs were done on that day. The record month consisted of 74 shifts of eight hours each.

The crosscut referred to is on the 143-meter level of the Europa mine, and at the end of the period the face was distant 1,237 ft. from the shaft. The muck was trammed by hand, in cars of 22 cu.ft. capacity, two men to a car. The shaft pocket was equipped with the common type of wooden chute gate and the ore was hoisted through a one-compartment shaft, fitted with wire-rope guides, in buckets of 700 kg. capacity. The mechanical equipment, while adequate, was of a temporary character.

A No. 7 Sirocco ventilating fan was used, belted to a 15 hp. electric motor. The gases were exhausted through a pipe line consisting of 15-in. pipe reduced further on to 12-in. size. The maximum length of ventilating pipe was 1,400 ft. Ingersoll-Rand S 80 machines were used and found entirely satisfactory. In general terms the rock would be described as favorable.

The crosscut was of approximately 6 by 6.5 ft. in cross section with a grade of one-quarter of 1 per cent. Sixteen-pound rails were laid with 20-in. gage. Turnouts were placed at about 220 ft. intervals. The ordinary type of mine car with roller bearings was used.

In driving, a heading was advanced so as to leave a bench about 18 in. high behind. This bench was shot with long lifter holes for every second round in the face. In the heading face a pyramid cut was drilled with two machines mounted on a horizontal bar. From twelve to sixteen holes were drilled for an ordinary round in the heading face, with eight to twenty-two holes as extreme cases. Steel was used in 1 ft. changes to a maximum length of 7 ft. The maximum advance per round was 5 ft. On some occasions the face was shot four times in the eight-hour shift.

LABOR

Work was carried on in eight-hour shifts, and for each shift the crew was as follows:

1 Foreman (Greek or Mexican)

Underground

1 jigger boss.
3 machine men.
3 machine helpers.
(The extra pair of machine men laid track or worked wherever required.)
1 pipe fitter.
1 pipe fitter helper.
12 muckers, who alternated as carmen.
1 extra mucker.
2 loaders at pocket.

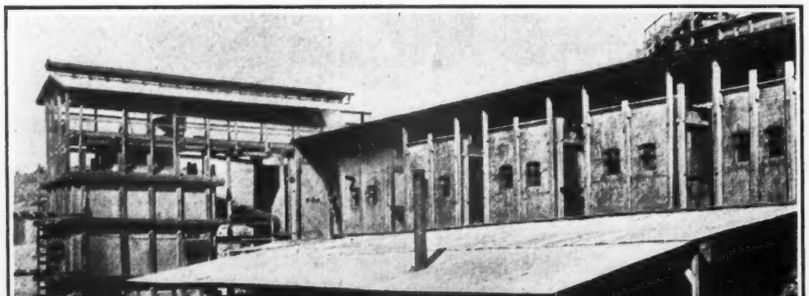
Surface

1 topman.
2 carmen on dump.
1 hoist man.
1 drill repair man.

Steel was sharpened at a central plant some four kilometers distant by road and delivered in a Ford truck. Compressed air was piped from a distance of about 1,000 meters. The ventilator ran continuously, and not more than twenty minutes was lost between shooting and starting on the next set-up.

MUCKING

After blasting a round the machine men mucked back from the face suffi-



Quicksilver furnace plant of Waldron Quicksilver Co., near Alpine, Tex.

ciently to permit them to set up the horizontal bar and then started drilling. Meanwhile, two of four muckers, standing in pairs, shoveled back toward those loading the car. Two men shoveled into the car from the usual position and two others shoveled between them. Two men pushed the loaded car toward the shaft and two others brought another car from the nearest siding to the face.

There were no elements of novelty in the methods adopted, and the record is simply due to doing the usual things a little better. The following factors contributed to the results obtained.

1. The energy and executive ability of the contractor.

2. High wages and liberal bonuses, which attracted the best men and secured their whole-hearted co-operation.

3. The high prices paid the contractor per meter, which enabled him to crowd men into the face without consideration of cost.

4. Good machine drills kept in perfect condition.

5. The provision of all supplies and materials when and where required.

It should be mentioned that this extreme speed is not economical in cost per foot driven and, further, that the men were working at a rate that they could not have been expected to keep up indefinitely. With few exceptions the efficiency of the men was noticed to fall off after two weeks' work.

As illustrating the price paid for speed, it is sufficient to note that considering only drillers, muckers, and trammers the advance per man per shift was only 0.58 ft. At the ordinary rate of work, two drillers and four muckers would break and tram a 5-ft. round in an eight-hour shift, which is equivalent to 0.83 ft. per man per shift. The drilling record follows:

Number of eight-hour shifts worked	74
Number of man-shifts worked	2,220
Advance per eight-hour shift, ft.	10.37
Advance per machine shift, ft.	5.19
Advance per man-shift (all labor) ft.	0.35
Advance per man-shift (drilling, mucking, and tramming only), ft.	0.58

The comparison between the number of men employed here and the number on the Tintic Standard job is striking. The Parral record establishes the possibilities of the Mexican miner when ably directed and given a sufficient financial incentive to exert his best efforts.

Mr. Hezzlewood, with his mechanical shovel, portable switch, and the good old mule, did almost as well with five men per shift as Page did with twenty-two men per shift.

New Baltic's Bottom Level in Good Ore

Arcadian Consolidated, at Houghton, Mich., has made a rich strike in the 1,250 level north drift in the New Baltic shaft. Mass copper more than a foot in width has been encountered in the vein, with good stamp rock on each side for the width of the lode. The drift is in 25 ft., the heavy mass being persistent throughout. The 1,250-ft. opening is the bottom level of the New Baltic shaft, in which development work was recently resumed. The find is considered an encouraging indication of strong mineralization at depth. Arcadian Consolidated has an extensive territory to the north, fully a half mile on the strike of the lode.

Silver Crown Plant Damaged by Storm

The Silver Crown Mining Co., of Crown King, Ariz., recently suffered heavy losses through damage done by storms. A landslide occurred close to the mill and destroyed the 40,000-gal. concrete reservoir. The released water rushed down the mountainside, carrying destruction in its path. The engine room of the mill was carried away and the compressor and receiver were destroyed. Two other engines were badly damaged.

The company was about ready to start milling ore, but this work will now be delayed until the machinery can be replaced and the damage repaired. The loss is estimated at $20,000.

Waldron Ships First Quicksilver

Freighters have brought to Alpine, Tex., the first load of 100 flasks of quicksilver from the Waldron mine, which has been stored for shipment. The roofing and cupola which were torn off the furnace by a storm on Feb. 14 at the mine in southern Brewster County, Tex., have been replaced, according to E. A. Waldron. He says that although the big blow caused considerable inconvenience and damaged the property to the extent of several hundred dollars, everything has been restored to good condition.

Congress Mine to Be Reopened

A syndicate has taken over the old Congress mine, in Arizona, and is planning to treat the dumps and also reopen the mine. This is the deepest gold mine in the state, as it was stoped to a depth of 4,200 ft. The shaft, which is at present full of water to the collar, will be unwatered gradually with a series of pumps at different levels. The water is to go into a mill which will be erected to treat the tailings. Average values of the vein are approximately $13 per ton over a width of one foot to five feet. As the ore persisted to the deep levels, mining will be resumed as soon as the water has been pumped from the lower levels with the equipment to be installed.

The Tom Reed, at Oatman, is again operating its own mine and mill, with about eighty men employed. The Katherine Treasure Vault is now down to the 400 level, and is preparing to drive its fourth crosscut through the rich vein encountered on the 110 and 250 levels. The vein is said to be 30 to 35 ft. wide.

An Aerial Survey Planned for African Concession

For the first time in African mining history, airplanes are to be used in making preliminary surveys, according to advices from G. K. Donald, U. S. consul at Johannesburg, South Africa, as made public by the U. S. Department of Commerce. The Rhodesia Congo Border Concessions, Ltd., has contracted with an English company for the surveying of their concession of 50,000 square miles on the Congo border of Northern Rhodesia, and the party of aviators with their equipment have now arrived in South Africa.

Work on the survey will be started about the end of April, and it is expected by those interested in the project that about one-half of the concession will be surveyed in four months. D. H. 9 planes equipped with Nimbus engines are to be used. The cameras will be electrically driven and will use No. 9 film, 65 ft. long, and taking 100 exposures 7 in. x 7 in. On the side of the film there is a margin of two inches on which will be shown the exact time of the exposure. Photographs will first be taken obliquely and from them a reconnaissance index will be prepared. The photographs will then be taken vertically and finally a map of the surveyed country will be drawn from the data thus collected.

Tri-State District Mill Burned

South African Subsidiary's New Plant Progressing—Interstate Company Gets Option on Two Tracts

Fire of unknown origin destroyed the 300-ton mill of the Tar Creek Mining Co., located three miles northwest of Picher, Okla., in the Joplin-Miami district, on March 23. It is believed the blaze started from a hot box in the tailing elevator, or possibly from a short-circuited wire. The loss was about $75,000, according to Fred J. Childress, who heads the company, and was mostly covered by insurance. The mill will be rebuilt immediately. It was one of the better mills of the Oklahoma section of the field. Good work by the fire department from Picher saved the blacksmith shop and other outbuildings, which were endangered.

The H. H. H. Mining Co. has taken over a lease of 120 acres adjoining its 20-acre lease northwest of Baxter Springs, in the Joplin-Miami field, and will prospect it thoroughly. The lease was obtained from the Vantage Mining Co.

In Oklahoma, the Interstate Lead & Zinc Co. has taken an option on the Lucky Jenny and Choctaw Chief leases, south of Hockerville, in the Joplin-Miami field. The two are valued at $100,000 in the option contract. Several drill rigs have been put to work on the tracts.

The Tri-State Zinc Co., Inc., a subsidiary of the Consolidated Gold Fields Co. of South Africa, is pushing work on construction of its new mill on the Blue Mound lease in the Joplin-Miami field. In addition it is sinking a new shaft on the west end of the Blue Diamond lease, which is the west forty acres of the Blue Mound lease. The company is also operating a number of leases in the southern part of the Oklahoma section of the field.

New Work at Ord Mine

At the Ord mine, south of Daggett, Calif., operated by the Ord Mountain Mines, Inc., an ore bin and surface gravity tram are under construction. After completion it is planned by the company to make weekly shipments to custom plants.

Dunwell mill under construction

Note: An aërial tramway now occupies the cut-over area above the mill

Silverton Thawing Out

Silverton, Colo., will resume communication with the outer world about March 27, according to predictions by officials in Silverton. The town has been hemmed in by snowslides and drifts for more than thirty days. Durango has also been affected by the heavy snows, although not as much as Silverton. The smelter at Durango will resume rail traffic soon. Sunnyside mine, of Silverton, has 5,400 tons of ore on siding and in bins ready to ship to Durango when the railroad resumes.

On the Durango end of the snowslide section, a steam shovel is being operated against the drifts, in places 35 to 46 ft. deep. The Sunnyside mine force is working in the center of the district and is encountering drifts of 20 and 25 ft.

St. Joe Said to Be Buyer

According to reports from Great Falls, Frank H. Skeels, who recently purchased the "Block P" mine, at Hughesville, Mont., from the T. C. Power estate, is acting for the St. Joseph Lead Co., and the consideration is said to have been $650,000. Mr. Skeels has given a contract to the hardware department of the Anaconda Copped Mining Co., to equip the mine fully with machinery, and one carload has already been shipped.

Dunwell Mill Started

The new Dunwell mill, in the Portland Canal mining division of British Columbia, was put into operation on Feb. 27. The ore is passed by a belt conveyor from a grizzly and gyratory crusher to two Hardinge No. 7 mills and thence to Dorr classifiers and Wilfley tables. Tailing from the tables goes to two sets of Minerals Separation cells. Flotation concentrate is dewatered in Dorr thickeners and then passes to Oliver filters.

The mill makes three products—argentiferous galena, argentiferous blende and auriferous pyrite concentrates. At present these are sacked at the tables and filters, as no storage facilities have been provided. The mill is operated electrically by a Canadian General Electric generator driven by a Vickers-Peters oil engine; later, when water storage has been provided, a Pelton wheel will be attached to the generator, and the oil engine will be used as an auxiliary during periods of water shortage.

The halftone illustrations presented on this page show the company's mill, the entrance to Tunnel No. 4, and part of the surface plant.

Real del Monte Shipping Zinc Ore to Europe

Large shipments of zinc ore are being made to Europe by the Cia. Real del Monte y Pachuca, of Hidalgo, Mexico. This company has been exporting its ore through Vera Cruz for some time. Shipments will hereafter be made through Tampico and on an increased scale, it is stated. The first of the company's exports through Tampico went forward recently and consisted of five hundred tons of ore, destined to Dunkirk, France.

The mines of the company at Pachuca are working at capacity, with no scarcity of labor. It is expected that the short-line railroad which is being constructed from an intersection with the existing lines of the National Railways of Mexico to Tampico will prove of great benefit to the Pachuca and other mining camps of the State of Hidalgo. It will provide a short rail transportation route for export and import shipments.

Entrance to No. 4 tunnel, Dunwell mine. Blacksmith shop in center; assay office at right; ore in dump

Weepah Still Booming

Without Good Reason—Nothing More Than Original Undeveloped Find to Date

The camp of Weepah, Nev., is still on the boom, with people coming in from all parts of the country. So far it is mainly due to efficient advertising and not to any remarkable showing there may be on the ground. Practically no work has been done to prove or disprove the value of the district. No work whatever has been done on the gold showing, as if one round of shots took out all of the gold the main stimulus for the wildcat companies would be gone.

There have been many sales of ground, with cash consideration from a maximum of $10,000 down to as low as $100 down, with short times for additional payments. Most of the claim owners are anxious to dispose of their holdings as soon as possible, and for cash, fearing that it will all be over in a week or so. Work will soon be started by several of the companies and then new strikes of small or large bunches may increase interest in the camp, or the lack of them decrease it.

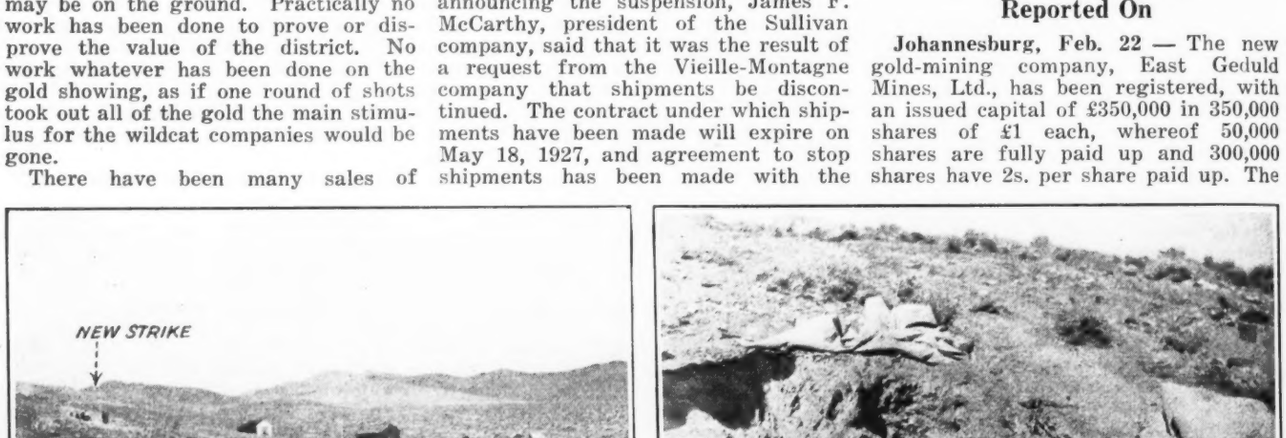
Human-interest stories are numerous, and there must have been twenty-five newspaper men in Tonopah and Weepah at different times writing up the district. One garage man in Tonopah loaned two boys ten gallons of gasoline to go out and locate additional claims, and they located him on a group of three claims. The group has been sold with a cash payment of $5,000, of which he received one-third, with $10,000 additional to be paid within a short time. These stories make good reading, and the newspapers are playing them strong.

Accident Shuts Dome Mines Down

The Dome Mines, of South Porcupine, northern Ontario, has been closed down since March 22, owing to an accident in the main shaft. The cable broke, releasing the basket and tearing the timbers out of the shaft, thus necessitating a suspension.

Ore Shipments from Star Mine to Belgium Stopped

The Sullivan Mining Co., operating the Star mine, in the Coeur d'Alene district, Idaho, suspended production on March 21. It has been producing 475 tons of zinc-lead ore per day, the zinc product being shipped to the Vieille-Montagne Zinc Co., of Belgium. In announcing the suspension, James F. McCarthy, president of the Sullivan company, said that it was the result of a request from the Vieille-Montagne company that shipments be discontinued. The contract under which shipments have been made will expire on May 18, 1927, and agreement to stop shipments has been made with the understanding that the contract is cancelled. The force at the Star will be reduced to about 28 men, who will be retained on development work, partly in ore and partly in waste. Such ore as is produced will be concentrated and the zinc concentrates stored pending the completion of the electrolytic zinc plant now being constructed by the Sullivan company at Kellogg, which will be ready by the first of 1928. The Star mine is owned jointly by the Hecla Mining Co. and the Bunker Hill & Sullivan company.



Left—The location of the new strike with respect to the "town" of Weepah, Nev., most of which metropolis is visible in the picture. Right—The cut where the high-grade gold ore was found, and where a second round had not been pulled up to the minute of going to press

Arizona Feldspar Property Sold

The feldspar property located 6 miles north of Kingman, Ariz., has been sold by the Kingman Feldspar Co. to the Gold Cliff Central Mining Co. The deposit is said to be 1,500 ft. long and 60 ft. in width. Tonnage at present blocked out for mining is 2,000,000 running 99 per cent in feldspar. The property also produces a clean grade of silica. Present production is only about 100 tons per week, but this is soon to be increased. The caving system is to be used.

The company has orders from manufacturers for 500 tons of feldspar and 350 tons of silica. These products are used chiefly in the making of tile, chinaware and coated ware. M. J. Kiely is president of the new company and George McDevitt secretary.

Johannesburg Letter

By John Watson

Special Correspondent

East Geduld Mines Registered—Northern Transvaal Copper Examined—Doornhoek Reported On

Johannesburg, Feb. 22 — The new gold-mining company, East Geduld Mines, Ltd., has been registered, with an issued capital of £350,000 in 350,000 shares of £1 each, whereof 50,000 shares are fully paid up and 300,000 shares have 2s. per share paid up. The board of the new company contains the following directors: P. M. Anderson, chairman; Sir R. N. Kotze, James MacGill Love, V. J. Ronketti, and Paul Strakosch. Prospecting has already started underground, on the new area by five headings from Geduld Proprietary Mines. Quarterly development reports are to be issued. East Geduld shares were introduced on the Johannesburg Stock Exchange last week.

Doornhoek Platinum Mines, Ltd., whose holdings, near Mylstroom are being worked as a tin property, expect the chairman of the company, Bernard Alexander, back from England on or about March 1. A prominent London financial group has appointed an engineer to report on the Doornhoek property, and it is said that he has sent, by this week's mail, a minute and exhaustive report. Doornhoek shares have been in demand last week.

The Northern Transvaal Copper Exploration property was recently visited by Alexander Souter, who has had long experience of the pitchblende deposits in the Belgian Congo. He considers the deposit in No. 5 shaft similar to the pitchblende of the Congo. Samples of the rock were submitted to Dr. Steuart and Dr. Olivier to be tested qualitatively for radio-activity. They reported that, with the exception of one doubtful case, the samples were all radio-active, one sample in particular being remarkably rich.

Calumet & Hecla Plans Extensive Exploratory Work

The plans of Calumet & Hecla Consolidated Copper Co. for extensive exploratory work in Keweenaw County, Mich., are of critical importance to the future of that company and the Michigan copper district. The program is based on fifteen years of study on the geology of copper occurrence in the district, the last seven years of which have been devoted to an intensive geological survey. As a result of these investigations, certain geological principles have been evolved which will serve as guides in exploration. These have been derived through determination of many of the chemical, mineralogical, and structural characteristics of known orebodies and their associated rocks. All of these types of geological evidence indicate quite definitely certain specific areas of outstanding attractiveness in Keweenaw County.

The first work will be undertaken at the old Cliff and Phoenix fissure workings, and if successful will be a fair test of the exploratory program as a whole. The company will have the benefit of control of an unbroken block of territory, estimated to be upward of 100,000 acres, four-year options having been taken on over 9,000 acres of intervening land of foreign ownership. It will be the first unified and consistent exploration program, based entirely on proved geological and practical mining considerations, ever carried out in the district, with a degree of confidence as to outcome not hitherto possible.

Mudd-Wiseman Property Sold

The Supply gold mines, in the Dale mining district of San Bernardino County, Calif., have been purchased by the Arrowhead Development Co. of Tonopah from Philip Wiseman and the heirs of the Seeley W. Mudd estate. The Arrowhead company operates the United Eastern mine, in Oatman. In addition to a cash payment a royalty will be paid the Mudd and Wiseman interests.

The property consists of seven patented claims, a 100-ton stamp mill, a cyanide plant, a hoist, a compressor, and pumping and electrical equipment. The mine is 35 miles south of Amboy, Calif.

North Carolina Seeks Statistics on Mineral Production

Under the provisions of a law just enacted, every producer of minerals in North Carolina is required to register with the State Department of Conservation and Development the name of the person, firm, or corporation, and the address; also the kind of material mined. This law refers to every kind of mineral taken from the ground in the state. The legislation was enacted to effect the compilation of complete statistics of the mineral production in North Carolina and for aid in further developing the state's resources. It is expected that the law will be an aid in building up markets for the state's minerals.

News From Washington

By PAUL WOOTON
Special Correspondent

Expert Sought to Organize Geophysical Work for Bureau—Drilling on Potash Land Soon

THE recent announcement that the U. S. Bureau of Mines will undertake a study of geophysical prospecting methods has been so well received that a more comprehensive program than was contemplated at first is to be undertaken. A large number of letters have reached the Bureau which indicate a broad demand for research work of this character.

As a result an effort is being made to secure the services of one of the best-known technical men in the country to organize, on a consulting basis, the program of work calculated to give the maximum results with the limited funds which are available. Since the Canadians have paid more attention to this development than we have, negotiations also are in progress to secure the services of two of their research men who are particularly well qualified to help. The co-operation of the geophysical laboratory of the Carnegie Institution and of the National Research Council has been assured.

Drilling for potash on private lands in Texas is expected to begin in the near future. The attorneys of the Commerce and Interior departments have about completed the contract based on the amended potash law. The four sites which the Geological Survey regards as most promising are in Texas, but the restrictions in the original act were such that the land owners would not sign the contract. This made it necessary to start the work on public lands in New Mexico. One well there now has attained a depth of 1,000 ft. The core is being sent to Washington for detailed analysis and study by the Geological Survey.

The Sullivan Machinery Co., of Chicago, has been awarded the contract for the drilling of the two other New Mexico wells. There were five other bidders. Steam-driven drills will be used on both locations. Water has to be brought in from a distance of 30 miles. It is of such poor quality for boiler use that two boilers will be set up at each location. This will allow operation to continue while one of the boilers is being cleaned.

The Bureau of Mines has received $25,000 from the American Petroleum Institute to be expended for a new "Story of Petroleum" film. The "Story of Petroleum" now being shown by the Bureau was made eight years ago. Since that time great progress has been made in operating and safety methods.

The Bureau has not as yet been able to arrange for a "Story of Iron." This is the only mining activity of that importance which is not covered in the series of motion pictures produced under Bureau auspices.

Bullard's Bar Dam Effective, Commission Finds

Opposition to the plans proposed for the resumption of hydraulic mining in California has centered around fears that the débris dams to be constructed will not effectively prevent débris from being deposited in the river bottoms and contiguous lands. The Sacramento Chamber of Commerce recently asked the California Débris Commission for information. Major C. S. Ridley sent the following reply:

"Mr. Egenhoff, engineer with the California Débris Commission, has just returned from a trip to Bullard's Bar dam and has brought back samples of the water now flowing over the crest of the dam. . . . It seems certain that the material going over the dam at the time the samples were taken could by no possible stretch of the imagination ever cause any damage to the Sacramento River or the adjacent lands. . . . The commission has arrived at no conclusion as to the feasibility of the resumption of mining. . . . However, if properly designed concrete dams are constructed, as contemplated in the report of the State Mining Commission, there is no reason why a resumption of hydraulic mining should prove detrimental to any of the rivers below the dams or to the lands adjacent thereto."

U. S. Smelting Starts Drilling Eureka, Utah, Property

Diamond-drilling operations of the Central Standard Consolidated Mines property at Eureka, Utah, by the United States Smelting, Refining & Mining Company have been begun. The first hole has reached a depth below 250 ft. Progress of 50 ft. daily is being averaged. Results will be watched with interest.

The Central Standard is north of the North Lily, adjoining the Tintic Standard. Opening of a large orebody in the former mine has revived interest in the East Tintic district.

Colorado Tungsten Companies Active

Colorado tungsten companies which were active during the war have renewed activities in Boulder, Colo., during the last month. The Wolf Tongue Mining Co. and the Tungsten Production Co., the two leading tungsten producers in the county, are increasing their forces and improving their holdings in the Nederland and Caribou districts. The Potosi-Caribou Co., financed by a group of New York capitalists, is doing development work in three levels extending out from a 400-ft. shaft.

Mexico City Letter

By W. L. Vail

Special Correspondent

Strike at Taviche—Miners at Cinco Minas Ask Six-Hour Day—New Placer Field in Guerrero

Mexico City, March 20—The National Mining Chamber of Mexico has re-elected for the ensuing year Genaro P. Garcia, of the Real del Monte company, Pachuca, president; Adolfo Martinez and Alexander G. Sauter, vice-presidents; Andreas Aldasoro, treasurer; Norborto Dominguez, secretary; and Ricardo E. Mora, Benjamin J. Silbert, Frederick McCoy, Henri Jouanen, and Carlos Robles, directors. The work of the chamber during the last year has been satisfactory, and a progressive program has been laid out for the ensuing term.

One of the outstanding benefits which the organization has rendered its membership and the mining industry in general has been in obtaining certain modifications of the new mining laws and reductions in taxes and freight rates for supplies and ores. The chamber is working for further amendments in conjunction with the mining organizations of various states in the republic.

The Taviche district, in Oaxaca, is having its first miners' strike in years. The trouble arose over the discharge of a number of men at the Asarco plant, who insist upon their immediate reinstatement. According to report, the state government is taking a hand in the matter.

The Parral & Durango Railway has a corps of engineers in the field, picking up the old survey line from Parral to Guanacevi, located twenty years ago. They expect to go as far as Quebrada Honda, which would bring the road to within three or four hours of Guanacevi.

The Cia. Min. de Peñoles has temporarily suspended work in this camp. It has blocked out some 150,000 tons of 700-gram silver ores, but is awaiting better conditions for shipment and resumption of work.

Colonel W. B. Thompson has acquired a number of properties in the San Pedro valley, adjacent to Guanacevi. The San Pedro has some of the largest silver orebodies in Mexico. There appear to be two series of ore depositions in this district—vertical veins that intersect at depth with a large flat contact of orebodies of gold and silver. Most of the old properties are flooded, and a project is now under way for the construction of a 2-km. tunnel for the purpose of unwatering the best mines. There is also a scarcity of fuel in the district and a complete lack of transportation. A continuation of the railway from Parral would bring in cheap oil. Plans for power plants have also been made.

From Sonora comes the statement that the Yaqui troubles have not greatly impeded mining. The Sonora Mining Co. is planning a smelter for its properties, located 11 miles southeast of Douglas, Ariz. Frank E. Barton, of Los Angeles, is president of the company. Colonel J. Campbell Beasley, owner of some properties near Moreno station, on the Southern Pacific Railway, is preparing to erect a small flotation mill.

The Mexican Mining Department has again advised foreign mine owners that all documents coming from abroad must be properly registered before being presented here; that the time for filing papers in order to legalize their status expires July 31 of this year; and that no extension of time will be granted. The expense attached to this formality can be ascertained by applying to the mining department or the information can be secured through any mining attorney's office.

In Jalisco, the miners' union at Cinco Minas is insisting upon a six-hour working day and making it effective at the present time by stopping work two hours each day, hoping to force the management into an agreement. The union miners at the Amparo have taken over the operation of the mine on their own account, leaving the mill in the hands of the company. At San Pedro Analco (property of the San Rafael of Pachuca) the mill remains closed, but exploration work is being done with diamond drills, and some development work is in progress.

The Bolaños mine has run into a rich body of ore, but recent revolutionary activities in that section have compelled the company to lay off approximately 300 men.

W. E. McEwen, superintendent of the Majestic Mining Co., with properties in the Totolapam district, en route, on vacation, for New York, says that the general situation in Oaxaca is excellent. With minor exceptions, the state is free from labor troubles and the state authorities have been extremely liberal with reference to taxation. The Majestic is making bi-monthly shipments of concentrates to the smelter at San Luis Potosi, aside from increasing development at the mines. Several hundred thousand pesos are being invested by the various mining camps in road betterment, the government allowing a rebate in mining taxes.

A new placer field is reported from the state of Guerrero and a large number of denouncements in that region have been filed during the past six weeks. The grounds are reported to be located on both sides of the Rio Balsas, and running across the line into the state of Michoacan.

A 200 ton flotation plant is being installed at Asientos, Aguascalientes, by the Minera Mining Co., and a large steam turbine unit at San Gil.

Washington Mine Changes Control

The Washington mine, on the East Belt, in Calaveras County, Calif., south of Sheep Ranch, has been taken over by the Hercules Gold Mines Co., a Nevada corporation. The property was recently controlled by the Pearce Holding & Purchasing Syndicate, also a Nevada corporation. Announcement has appeared that the mine is to be operated under the supervision of J. O. Gallice. Various attempts have been made to operate this property at different times.

London Letter

By W. A. Doman

Special Correspondent

Bauchi-Bisichi Deal Off—Solly Joel in Platinums—Soviet to Cancel Concessions

London, March 15—The hydro-electric installation at the Kwall Falls, in Nigeria, has proved so successful, increasing the production of the Northern Nigeria (Bauchi) company from 40 to 150 tons of tin concentrates monthly, that it is now proposed to harness the Kurra Falls in a similar manner, mainly for the purpose of supplying power to the Nigerian Base Metals Corporation and its subsidiaries. The company formed to undertake this work is called the Nigerian Power & Tin Fields. As I mentioned on a recent occasion, it is believed that the control of the Nigerian Base Metals Corporation will be transferred to the Consolidated Mines Selection, or the sister company, the Anglo-American Corporation of South Africa.

Some time ago the Bauchi company made an offer to the Bisichi Tin Co., Ltd., operating in Nigeria, to take over its assets for a share consideration. The Bisichi machinery was not working satisfactorily. The Bauchi company apparently thought the deal would go through, and issued a circular stating the terms, and regarding them as good. The Bisichi company, evidently thought they were not good enough and refused to continue the negotiations. Since then there has been a conflict of opinion between the boards of the two companies, the Bisichi directors resenting the premature publication of the negotiations without their knowledge. At present, therefore, the deal is definitely off.

Frank B. Powell, the consulting engineer to the Barrier & General Trust, which is changing its name to Barrier & General Finance, is in Nigeria examining properties on behalf of the Trust, and it is supposed to be in this connection that the Trust is proposing to increase its capital.

When the original platinum boom was at its height I recorded that Solly Joel and the Johannesburg Consolidated Investment Co. would have nothing to do with companies formed in the Transvaal to work the deposits. The position is now much altered. Solly Joel has been in South Africa and has examined various areas and taken an important interest in Potgietersrust Platinums, Ltd. He has evidently satisfied himself that there are big possibilities in platinum. The company has a capital of £1,500,000 in 5s. shares, and Mr. Joel has secured an option on 1,000,000 shares at 9s. a share. These are being offered to Consolidated Investment shareholders. According to the information supplied, good values are being exposed, and though much work has yet to be done, the prospects are reported to be favorable. It is gratifying that Solly Joel has taken such an important interest, for the discoveries are reported to cover a large area, and they have been described as constituting a Platinum Rand.

Melbourne Letter

By Peter G. Tait
Special Correspondent

Federation Tin Erecting Mill—Golden Horseshoe and Great Boulder Pty. to Merge

Melbourne, Feb. 18.—Carl Raymond Davis, chief consulting engineer of the Anglo-American Corporation of South Africa, Ltd., has arrived in Australia and will proceed immediately to Mount Isa. H. A. Titcomb and R. M. Goppert, of the same company's staff, are already on the field and have started a thorough examination of the mines. The Anglo-American Corporation has acquired 50,000 shares in the Mount Isa company and has an option on an additional 550,000 £1 shares at par. The report when complete will be forwarded to the London directors, and any announcement as to the intentions of the company will come from that center.

Some years ago attempts were made to work the graphite deposits known to exist in South Australia and Western Australia, but the production to date is unimportant. R. L. Jack, of the South Australian Geological Survey, recently furnished a report on the deposits at Port Lincoln. He states that from 63,200 tons of ore in sight, 7,027 tons of flake and 1,500 tons of finely divided graphite can be recovered. This, he says, would be worth about £173,000. Costs are estimated at 22s. a ton, leaving a profit of £100,000, less £10,000 on equipment and £5,000 for working capital. The report expresses the belief that additional ore will be disclosed.

O. B. Williams, formerly of Broken Hill and latterly general manager of the North Mount Farrell Silver Lead Co., Tasmania, is leaving for the Federated Malay States to join a former Broken Hill manager, H. V. Seale, who is the superintendent engineer for the Malay Siamese Prospecting Co., an Australian venture which has already floated several promising tin-mining companies.

As reported recently, the Federation tin mine, at Heemskirk, in Tasmania, with the aid of London capital is erecting a mill on that property and should reach the production stage within twelve months. Another Tasmanian field of which more will probably be heard in the near future is Renison Bell, to the northwest of Zeehan.

A syndicate has obtained options over a large area of proved ground from which considerable tonnages of rich sulphides have been extracted, leaving extensive deposits of comparatively low-grade oxide ore to be treated. The syndicate has already carried out extensive examination of the field, and it is understood that the prospectus of a new company to be formed will soon be issued. Malayan interests have also been actively engaged prospecting areas in Tasmania, New South Wales, and Queensland, with a view to the introduction of dredging methods, but so far no area has been definitely proved. The northeastern part of Victoria is highly mineralized and the occurrence of tin has been known for many years. Recent prospecting operations near Mitta Mitta have resulted in the formation of several companies to work that area.

S. N. Rodda, a well-known mining engineer, has recently reported on the property of the Bowonga Tin Mines. He states that some of the lodes attain a width of 50 to 100 ft. and outcrop 60 to 70 ft. high. One lode in particular outcrops for 150 ft. in length, 70 ft. in height, and is 30 to 40 ft. wide, the ore being estimated to average 2 per cent tin.

It is reported unofficially from Kalgoorlie that there will be an amalgamation of the Great Boulder Pty. and the Golden Horseshoe gold mines, and that negotiations are proceeding for the Lake View and Star to join in a merger. More may be heard of this proposal in the near future.

There is nothing authoritative to report in regard to the Glenelg Hill gold fields. The Glenelg Queen lease, held under option by A. H. Collier and some of his friends in London, is being developed under the management of J. McDermott, of Kalgoorlie, but it is impossible to obtain any official information. Those who know the country are inclined to the opinion that the shoots of ore will be very short. Up to the present there has not been a complete examination of the district by an independent mining geologist, so that data are scanty.

G. C. Norris, chief metallurgist with the Rhodesia-Broken Hill Co., North Rhodesia, arrived in Australia recently on a visit. The company expects to be in a position to produce 50 tons of electrolytic zinc per day when the plant is completed, about October next. Reserves in sight ensure a life of fifteen to twenty years.

New Mill Ready at Ouray

The Colorado Incorporated Mines, of Ouray, Colo., has just finished spending more than $250,000 in building a new 100-ton mill and in making other needed improvements. The plant will be in operation soon, and it is expected that a carload of concentrates a day will be shipped. The mill is located at one side of Bear Creek Falls near Ouray. For the past year the force at the mine, mill, and tramway has varied from 60 to 75 men, and with the mill running a larger number will be required.

North Star Mine Completes Vertical Shaft

Final connection of the new and old vertical shaft sections at the North Star mine, near Grass Valley, Calif., was recently completed and hoisting begun. The North Star shaft is the second deepest vertical shaft in California, being exceeded only by the working shaft of the Kennedy mine, at Jackson. The shaft bottom at the North Star is 1,050 ft. below sea level. The shaft develops a total length of 8,600 ft. measured upon the dip of the vein. J. Fred Johnson, of Eureka, Utah, took the contract to sink the shaft to its present depth and successfully completed the work.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Brokers on Carpet—More Power for Northern Camps—Weather Colder

Directors of the Standard Stock and Mining Exchange of Toronto are taking drastic action in connection with some of the stocks listed on that exchange. Three brokerage houses have been called on the carpet to explain charges of high-pressure selling methods and the stocks have been transferred from the listed to the unlisted section. It is claimed that in the case of two of the stocks a very small floating supply was employed as an instrument to raise quotations beyond normal speculative values and the companies concerned have also been very lax in issuing annual reports and holding annual meetings. New forces have been at work in the exchange for some time to bring about a general housecleaning, which will greatly assist in re-establishing public confidence.

During the last week there has been considerable cold weather throughout northern Ontario, and transportation conditions have improved, although there has been very little snow. It is now expected that the Nipissing may be able to get its plant in from Cheminis to Mountbray, and in the event of this proving impossible a small gasoline outfit can be sent in, which will permit sinking at least to the 100 ft. level.

The Hollinger has also been rushing supplies into its Kamiskotia copper claims and a few days ago nine teams loaded with a mining plant left for the property.

An interesting decision was recently handed down by Judge Godson of the Mining Court of Ontario, in connection with the Hollinger Kamiskotia properties. Jamieson, the original staker of the property, was a member of a syndicate that was subsequently disbanded. When Jamieson staked further claims and made a deal with the Hollinger for them, some of the individual members of the syndicate claimed that they were entitled to the same interest. This stand was taken because of the fact that Jamieson staked some of the claims with licenses in the names of the old syndicate members. Jamieson's position, however, was upheld by Judge Godson, who gave him full title to the claims staked after the disbanding of the syndicate.

The Canada Northern Power Corporation, which serves the mines of northern Ontario and Quebec, has decided to install two more units of 10,000 hp. each at the Quinze plant, which will bring that installation up to 40,000 hp. This increase is considered advisable to take care of anticipated increases at Kirkland Lake and Rouyn. The work will involve an expenditure of $1,250,000 and should be completed during the present year. The power company has been sufficiently impressed with the possibilities of the Kirkland and Rouyn camps to make a total expenditure of $3,000,000 in increases and betterments of its present plant.

Societies, Addresses, and Reports

Future of the South Discussed at Birmingham

Second Industrial Conference Held Under Auspices of American Mining Congress

GEOLOGISTS and leaders of industry and finance gathered at the second annual meeting of the Southern Industrial Conference that was held in Birmingham, Ala., on March 21 and 22, under the auspices of the Southern Division of the American Mining Congress. The sessions were held at the Tutwiler. J. L. Folse, manager of the Mississippi State Board of Development, presided at the opening conference.

Governor Graves of Alabama delivered the address of welcome. He spoke optimistically of the future of the state and quoted from Babson that Alabama would become one of the most important states of the country. What was true of it was true of all the Southland. There was knowledge, industry, and faith.

Responding, James F. Callbreath, secretary of the Mining Congress, told of its operations and of its varied interest in matters of general and local development. With regard to Muscle Shoals he said that his organization did not believe that the government should enter a business and compete with private enterprise. Responses were made by representatives of the various states.

The first paper of the conference—on "Southern Development," by Richard H. Edmonds, editor of the *Manufacturers' Record*—was read by the presiding officer. After describing the resources of the South, the author of the paper said that to insure the fullest use of these it was necessary to have a protective tariff high enough to safeguard the country against the pauper labor of the Orient and the near-pauper labor of Europe.

Judge J. A. Emery, of the National Association of Manufacturers, then spoke on "Industry and Community Development."

McKinley W. Kreigh, chief of tax division of the American Mining Congress, spoke on "Simplification of Federal and State Taxation Problems." He told of the reduction of federal taxes from $25,000,000,000 to $19,000,000,000 and of the increase of state and local taxes from $7,000,000,000 in 1919 to $13,000,000,000 in 1926. "We are in the throes of a public debt making, public money spending orgy for which we are responsible," said the speaker. "We are incurring debts or permitting them to be incurred which are amounting to great sums."

"The government is collecting between $500,000,000 and $600,000,000 annually more than is necessary to meet its needs and the country is justified in expecting a tax reduction in the near future," the speaker said. "Taxpayers should determine how this reduction should apply in order that it may be made on an economic and scientific basis, and not upon political considerations. There is danger that the prosperity of the country and the ease with which revenues have been raised have made taxpayers complacent about the manner in which public funds have been raised and spent. Our several governments are reckless, in many instances to the point of wasteful extravagance, in the expenditure of those funds."

Mr. Kreigh stated that the federal tax system should be simplified to reduce the cost of its administration. He said that the expense of maintaining the Internal Revenue Bureau amounted to $35,000,000 annually, and that incurred by taxpayers to many times that amount. In the field of state and local taxation, Mr. Kreigh said, the principal problems were, what taxes are necessary and what are unnecessary; what bond issues should be made and what defeated; and what expenditures should be authorized and what should be deferred, reduced, or eliminated.

Coal and water power are both essential to industry and commerce, M. O. Leighton, consulting engineer of Washington, D. C., said in an address to the congress, presented by Dr. Henry Mace Payne in the absence of Mr. Leighton.

Hydro-electric power has increased the demand for fuel. The steam electric coal market is not growing as fast as the steam electric company. Instead of opposing water-power development, the coal industry should cultivate and exploit markets in which the use of coal is not so highly efficient as in steam electric generation.

This was followed by an address by Dr. E. F. Burchard, geologist of the U. S. Geological Survey, on "The Iron Ore Situation in the South" (also presented by Dr. Payne).

James L. Davidson, secretary of the Alabama Mining Institute, talked on "Advances in Safety Work," stressing the improvements made in the majority of Alabama mines along such lines. People in the mining districts are now being taught first aid, he said, and where there is such knowledge the frequency of accidents has been but one-eighth as great as at those camps where first aid is not known by the people, particularly the miners, who perhaps most need to know it.

Judge J. H. Hand, special agent of the Arkansas Department of Geology and Mining, told of Arkansas' part in building the great Southern industrial empire, outlining the possibilities in mining of zinc, aluminum, and other products, and the extraction of oil in superabundant quantities. Within the last three years, he said, the mining industry has grown from small beginnings to the point that last year the State of Arkansas received more than $2,000,000 in taxes on mining property. He painted Arkansas as the wonder state of the Union and declared its industrial possibilities unlimited.

William H. Lindsey, of Nashville, Tenn., president of the American Mining Congress, was introduced Tuesday morning, as was President Odell of the Gulf, Mobile & Northern Railroad.

The first speaker of the second day of the conference was Waldo Newcomer, former president of the international bank division, American Bankers' Association, and now chairman of the board of the Baltimore Trust Company, Baltimore, whose subject was "Banking and Mining." It dealt with the relationship of the banker and the man who operates mines. He said that the bank is usually careful on the question of mining properties. The duty of the miner is to find a bank large enough and then the banker must have knowledge. While a merchant seeking a loan wants temporary loan, mining development is different. Integrity and moral risk are questions looked into. Engineers' reports of miners are studied by banks.

OFFICERS ELECTED

The officers elected were as follows: R. G. Brown, of Louisville, Miss., chairman for the Southern division; Dr. Henry Mace Payne, secretary; Board of Governors: For Alabama, Theodore Swann, of Birmingham; for Arkansas, J. H. Hand, of Yellville; for Florida, C. G. Montgomery, Mulberry; for Georgia, Dr. A. V. Henry, of Atlanta; for Kentucky, J. E. Johnson, Lexington; for Louisiana, W. H. Sullivan, of Bogalusa; for Mississippi, R. G. Brown, of Louisville; for North Carolina, Dr. A. F. Greaves, of Raleigh; for South Carolina, E. L. Hertzog, of Spartanburg; for Tennessee, Howard I. Young, of Mascot; for Texas, J. H. Little, of Daco; for Virginia, C. W. Johnson, of Norfolk.

Delegates left after the meeting on a special train as guests of the Tennessee Coal, Iron & Railroad Co., the Louisville & Nashville Railroad and the Alabama Mining Institute for a trip around the immediate industrial district, inspecting the steel corporation's high-line railroad and the Fairfield steel plants.

Our Supply of Manganese Ore to Be Studied

A meeting of national interest and vital importance will be held in Cleveland, Ohio, on April 19 and 20, under the auspices of the American Institute of Mining and Metallurgical Engineers, Ohio Section, to discuss ways and means of providing adequate supplies of manganese ore for the protection of the steel industry of this country.

It is expected there will be a large attendance of steel and blast-furnace company officials and mining engineers from all sections of the country. The Secretary of War will attend, and leading government officials connected with the U. S. Geological Survey and Bureau of Mines.

Papers will be presented by the following, relating to the occurrence, uses, and economic status of manganese and other essential minerals necessary for

At the banquet of the Second Industrial Conference at the Tutwiler Hotel in Birmingham, Ala., on March 22. *(See opposite page)*

the production of steel in times of peace and war: Dr. C. K. Leith, University of Wisconsin; J. V. W. Reynders; Sir Robert Hadfield, of London, England; E. A. Kitson, of South Africa; Carl Zapffe, Northwestern Improvement Co., Brainerd, Minn.; Prof. H. M. Boylston, Case School of Applied Science; T. L. Joseph, of the U. S. Bureau of Mines.

The following compose the program committee:

Dr. R. C. Allen, chairman, vice-president and general manager of mines, Oglebay, Norton & Co., Cleveland, and ex-vice-president of the Lake Superior Iron Ore Association; Dr. H. Foster Bain, secretary of the A.I.M.E., and Benedict Crowell, ex-assistant Secretary of War.

All communications relative to the meeting and hotel accommodations should be addressed to C. B. Murray, of Crowell-Murray, Perry-Payne Building, Cleveland, Ohio.

Safety Congress at Kansas City April 13-14

The First Annual Central States Safety Congress will convene at Kansas City on April 13, with representatives from fifteen commonwealths between the Rockies and the Mississippi, to discuss safety problems. This meeting is sponsored by the National and Kansas City Safety Councils and various regional bodies. Opening with a general session on April 13, there follows an industrial session, at which these subjects will be presented: "Organizing the Plant for Safety," "Every Foreman a Safety Director," and "Keeping the Safety Committee Alive." The Mining Section of the National Safety Council will be represented by a large delegation, and a special session for this group has been arranged for April 14. All sessions affecting the Mining Section will be held at the Muehlebach Hotel.

New Mexico Students in Field

The senior class of the New Mexico School of Mines started on April 2 on its annual inspection and field trip. The party is in charge of E. H. Wells, president of the school, and Professor A. S. Walter.

Northern Michigan Mining Research Program Reported Well Advanced

THE research programs outlined by the advisory committees on iron and copper in the Michigan iron and copper districts, under the direction of Dr. W. O. Hotchkiss, president of the Michigan College of Mining and Technology, of Houghton, is well under way. The various departments of Michigan "Tech" have been organized and much of the preliminary work has been done.

In general, the work thus far has been confined to the problems of beneficiation of certain iron ores and the study of copper metal and ores. Other minor problems have been attacked, some of which have been brought to a satisfactory conclusion.

The iron-ore research has had the benefit of a full-time investigator for the last five months and may be considered as being advanced. A large amount of data has been accumulated, and though the work has been mainly fundamental, several possible avenues of investigation have been suggested.

The work on copper has consisted of pyrometallurgical investigations on smelting and refining, some work on milling, and a small amount on the fundamental properties of the metal.

Of the subjects of major importance other than the two noted, flotation has received its full share of time, and the investigation of other minerals and metals of the upper peninsula of Michigan has begun. Contracts have been established with most of the mining organizations of the iron and copper districts, and a healthy spirit of cooperation exists.

Early in the iron investigation it became necessary to develop a method for the determination, chemically and quantitatively, of the sulphur minerals in the iron ores. This has been satisfactorily completed.

An elaborate study of the solubility of gypsum and other sulphur-bearing minerals in the iron ores is now in progress. Mine waters from several properties have been analyzed and the possibility of water being the sulphur carrier has been eliminated. Sizing tests to show the distribution and size of the sulphur carriers have been carried out.

An experiment to investigate the results of sulphur removal by weathering of the sulphur and its incidental leaching in stockpiles shows that little can be hoped for from this phase, as the mixed sizes which are stocked tend to form a perfect water shed and the sulphur was removed appreciably only from the top 2 or 3 in. of the pile. Samples were taken from a trench at intervals of 6 in. in depth for a distance of several feet. Counter-current decantation experiments are in progress, but seem to be ineffective except in the case of gypsum.

Heavy density pulps as a separating medium have been investigated with the purpose in view of making a concentration of ores the iron content of which is low.

Filing and tabulating of literature on the subjects under investigation have begun. The work has been organized and the data are available for all investigators.

Alaska School of Mines Trains Prospectors

Each year the Alaska School of Mines at Fairbanks, Alaska, offers two courses, lasting ten weeks each, for prospectors and miners. This work includes elementary training in the principles of geology, mining, and mineralogy. Each year it draws prospectors and small mine owners from all points in the territory. Men from interior points often travel 300 to 400 miles with dog teams to reach the college for this work. This year twenty-five men were trained. These men return to the hills and have a ready opportunity to test out the training which they receive. Alaska is a thinly populated country, but probably two-thirds of the population is interested directly or indirectly in mining; hence prospecting is far from being a lost art.

U. S. Bureau of Mines rescue car No. 11 has been on the campus of the Alaska School of Mines for the past month, during which time Russell G. Thornburg, foreman miner for the Bureau, has given instruction in mine rescue and first-aid training to a class of thirty men.

People You Should Know About

A. W. Allen has left New York for London.

R. V. Thornburgh has established an office at 2317 Ward St., Berkeley, Calif.

Colonel J. Owen James, consulting mining engineer of London, England, recently passed through San Francisco.

Gerald FitzGerald, of the Alaskan Branch of the U. S. Geological Survey, reached Fort Yukon, Alaska, on March 21.

E. J. Raddatz, president and general manager of the Tintic Standard, is spending a few weeks' vacation in California.

R. W. Brigstocke is in the Slocan district of British Columbia, where he will spend two weeks or more in professional work.

E. E. Barker, mining engineer on the engineering staff of Utah Copper, has just returned from a visit to the Mount Morgan mine, in Queensland, Australia.

Lieutenant Colonel S. B. Joel, chairman of the J.C.I., or Barnato group, with Mrs. and Miss Joel, recently sailed from Capetown on their return voyage to London.

H. E. Doelle, who until recently has been in charge of the Ankerite property of the Porcupine Goldfields Development & Finance Co., is in New York for a short stay.

Walter Fitch, president, and **Thomas Carmichael,** secretary, of the Chief Consolidated Mining Co., have returned to Salt Lake City after a business trip to Washington, D. C.

John Daniell, of Los Angeles, has just returned from investigating the mines of the Great Bend Mines Co., the Gold Road mine, at Oatman, and the White Hills mines, at White Hills, Ariz.

R. de Sallier du Pin is now occupying the post of representative for all North and South American copper producers on the Brussels Committee of Copper Exporters, Inc., at 14 rue de la Chancellerie, Brussels.

Arthur Notman and **Felix Edgar Wormser** are substituting for **Prof. R. M. Raymond** in lecture work on mining engineering at the Columbia School of Mines during Professor Raymond's absence on sabbatical leave.

Colonel Stephen Pollen, who served in the Great War, arrived recently in Johannesburg. He is now a director of the Central Mining and Investment Corporation, and also chairman of the British Aluminium Company.

Rush T. Sill, consulting engineer of mines, of Los Angeles, and **Van Court Warren,** consulting geologist, of the same city, have just completed a report on the Clay district, Ash Meadows, Nye County, Nev., and Inyo County, Calif.

A. S. Walter, professor of mining and metallurgy at the New Mexico School of Mines. has returned to Socorro, N. M., from Pinos Altos, N. M., when he made an examination of the mining property and mill of the Calumet-New Mexico Mining Co.

H. C. Enos, of Los Angeles, formerly of the engineering staff of the U. S. Smelting, Refining & Mining Co., and later directing the operations of a number of mining companies in Mexico, has been engaged by the Park-Bingham Mining Co. to develop that company's property at Bingham, Utah.

Walter Douglas

Walter Douglas, president of the Phelps Dodge Corporation, of New York, accompanied by Mrs. Douglas and their daughters, arrived in Johannesburg recently, and left for the Congo Feb. 12 to visit copper properties.

William H. Lindsey, of the Napier Iron Works, Nashville, Tenn., has been elected president of the American Mining Congress, succeeding **Hugh Shirkie. Robert E. Talley** was elected first vice-president; **George B. Harrington** second vice-president, and **H. W. Seaman** third vice-president.

Howard C. Worden, of the San Francisco office, and **H. W. Clarke,** of the New York office of the McGraw-Hill Company, recently were in Butte and inspected the underground workings at Meaderville and the smelter at Anaconda of the Anaconda Copper Mining Co. They represent *Engineering and Mining Journal* and *Coal Age.*

G. C. R. Stewart, general superintendent of the Rio Tinto mines, of Spain, recently spent about a week in Butte and Anaconda inspecting the mining and smelting operations of the Anaconda Copper Mining Co. A number of years ago Mr. Stewart was in the employ of the Anaconda company at its Leonard mine.

D. C. Jackling, president of the Utah Copper Co., visited the copper properties of the Nevada Consolidated Copper Co., at Ely, Nev., during March and the Utah Copper Co., at Bingham, Arthur, and Magna. From Salt Lake City Mr. Jackling went to Butte for a day's visit to the Butte & Superior and then on to New York to attend the annual meetings of his companies.

P. K. Horner, formerly general manager of Union Minière du Haut-Katanga and now chief consulting engineer of Minerals Separation, Ltd., has sailed from England for New York and will arrive early in April. He will visit his former home in Missouri. A number of important copper deposits in Northern and Southern Rhodesia are being developed under Mr. Horner's direction.

Dr. N. L. Bowen, petrologist of the Carnegie Geophysical Laboratory, delivered a series of seven lectures in March before the Geology Club of Princeton University, on the "Origin of Igneous Rocks Through Fractional Crystallization;" and he also delivered a lecture before the combined Geology and Chemical clubs on "The Chemical Studies of the Geophysical Laboratory: Their Geologic and Technologic Significance."

C. Colcock Jones, of Los Angeles, is at Mogollon, N. M., collaborating with **Fayette A. Jones** and **Charles J. Hutchison,** of New Mexico, in the examination of the mines and properties involved in the suit of their clients, O. D. Burnum and the Kirkpatrick heirs, against the Mogollon Mines Co., for underground trespass and extraction of ore. Trial of the issue will soon be had before the United States district court at Santa Fe, N. M.

Obituary

William Ross, chief electrician of the Mining Corporation of Canada, was accidentally electrocuted at the company's plant at Cobalt, Ontario, on March 18.

William Healey Dall, from 1884 to 1925 paleontologist of the U. S. Geological Survey, died in Washington on March 27, at the age of eighty-two. Mr. Dall was a student of Louis Agassiz, and also studied at Wesleyan University and the University of Pennsylvania. He was a member of the International Telegraph Expedition to Alaska, in 1865, and served in the Alaska Coast Survey from 1871 to 1884. He was an honorary curator at the U. S. National Museum, professor at the Wagner Institute of Sciences, Philadelphia, member of the National Academy of Arts and Sciences and a fellow of the American Academy of Arts and Sciences. His wife and three children survive.

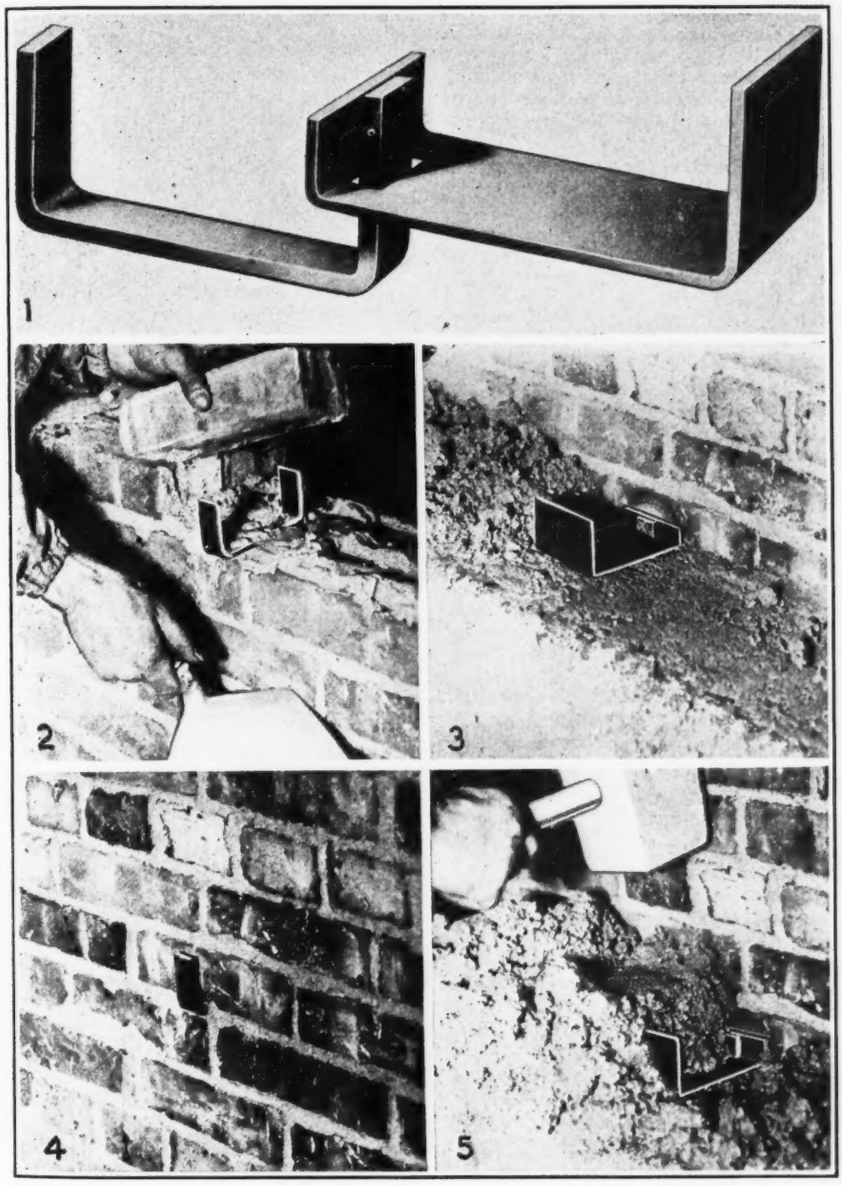
Charles W. Potts, of Deerwood, Minn., a mining man intimately identified with the development of Minnesota iron and manganese properties, died at Rochester, Minn., on March 22, following an operation. Mr. Potts was in his fiftieth year. He was born in Kansas, and was graduated from the University of Nebraska in 1903, with the degrees of LL.B. and A.B. Having no liking for the practice of law, Mr. Potts became associated with the land department of the Northwestern Railroad Co., and through his work for that company developed an interest in geology and mining, which culminated in his organization of the Potts Exploration Co., which conducted extensive drilling operations on the Cuyuna range. During the World War Mr. Potts was in the service of the government. He was an authority in manganese and the tariff, and for a time vice-president of the American Mining Congress.

New Machinery and Inventions

Furnace Wall Anchoring Plan Prevents Bulging

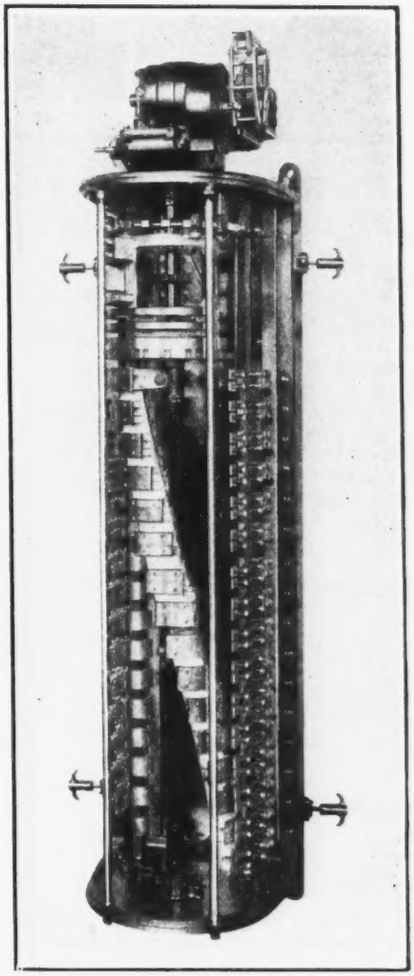
The "flexo-anchor" is a device that allows a one-piece monolithic furnace wall to move in any direction with expansion and contraction, thereby providing for the difference in these movements between the common brick and the refractory lining. It is claimed also that this device at the same time anchors the refractory to the common brick wall, effectually preventing bulging. It is being manufactured by the Plibrico Jointless Firebrick Co., Chicago, Ill., manufacturers of plastic Plibrico furnace lining.

The new anchor is a simple device; the hook is secured in the common brick wall. Then as the wall of plastic Plibrico is built up the anchor is placed over the hook. As the wall rises the anchor is embedded in the Plibrico. This new anchor is used in both new settings and repair jobs. On old work a brick is first pried loose; the hook is then inserted in the wall and finally the brick firmly wedged back into place.



A wall-anchor that can be used in repair work or new construction

This wall-anchor, it is stated, provides for the difference in expansion and contraction between common brick and a refractory furnace lining. At 2 in the above illustration is shown the method of securing the hook in the common brick. At 3 the Plibrico wall is built up and the anchor is in place. At 4 the wall with the anchor inserted is ready for its protective coating and at 5 the plastic covering is being applied around the anchor. The anchor itself is shown at the top of the illustration.



This switch is for delicate speed control

Unique Controller Designed for Fine Speed Adjusting

A 31-point drum switch designed by the General Electric Co., Schenectady, N. Y., has resulted from a demand by central power station operators for finer speed adjustment of slip-ring motors applied to forced and induced-draft fans. To burn fuel efficiently requires that the proper proportion of fuel and air be maintained at all times and that the draft fans be capable of accurate adjustment to changes in fuel feed. The value of this is evident when it is realized that the cost of fuel represents more than half the cost of electricity as generated by the modern steam plant. The new switch is made in both 150- and 300-amp. sizes with either alternating-current or direct-current pilot motor for remote control. Because of the large physical dimensions of the 300-amp. size, only the 150-amp. size is designed for manual operation.

For cases where the 50 per cent speed reduction obtainable with one slip-ring motor is not sufficient, a double-motor drive using two motors of different speeds is commonly applied. One of these switches can be adapted for use with the two machines.

Market and Financial News

Phelps Dodge Profits Declined in 1926

Net "Loss" of $947,598 After Charging $5,058,005 to Depletion

WITH the exception of the amount paid as dividends — $2,750,000, against $2,000,000 in 1925 — the recently issued report of the Phelps Dodge Corporation is a record of declines. Production, selling price of copper, expense, profits, and profit-and-loss surplus all showed a reduction, as indicated in the accompanying tables.

Copper ore production from the limestone mines of the Copper Queen branch, says the report, was considerably less than in the previous year, both from company and lease-ore shipments. The grade of ore showed a marked falling off, due to the exhaustion of the high grade ore in the Southwest Division. The orebodies as a whole are becoming smaller, more scattered, and mixed with waste. These conditions not only increase mining costs but make it impossible to maintain tonnage and copper content. Lead-ore production, including company and lease operations, was less than in 1925, and in October company shipments of lead ore were suspended until such time as the new lead concentrator and smelter should be in operation. In addition to copper and lead ore mined by leasers, 2,490 tons of manganese ore was shipped. Adjoining the Sacramento Hill orebody, which is being mined by steam shovels, is a large quantity of similar porphyry ore, only at a greater depth under the surface. As yet no satisfactory plan has been worked out for mining this low-grade ore. The caving operations started last year in the southeast extension of the orebody have progressed very satisfactorily and are now furnishing about 25 per cent of the total tonnage to the concentrator.

Phelps Dodge Financial Report

	1926	1925
Gross income	$38,424,038	$39,707,084
Expenses	31,175,849	31,753,604
Interest	.....	428,429
Depreciation	2,378,523	2,467,046
Profit	$4,869,666	$5,058,005
Depletion	5,817,264	6,211,686
Net loss	$947,598	$1,153,681
Dividends	2,750,000	2,000,000
Deficit	$3,697,598	$3,153,681
Previous surplus	77,784,852	80,938,533
Profit-and-loss surplus	$74,087,254	$77,784,852

A total of 1,140,332 cu.yd. of ore and waste was removed from Sacramento Hill during 1926. Of this, 398,694 tons of material, averaging 0.74 per cent copper, went to the leach dumps. Ore produced totaled 1,247,612 tons, of which 116,078 went to the smelter direct.

A decreased tonnage of milling ore was shipped from the hill compared with the previous year, but a heavier tonnage of smelting ore is reported. The stripping ratio was 1 of ore to 1.04 of waste, against 1 to 1.43 in the previous year. The steam-shovel operations for the past year may be considered quite satisfactory and yardage costs and efficiencies were maintained, notwithstanding the decreased amount of material handled.

The concentrator handled 1,322,342 tons of ore, averaging 1.61 per cent copper. Part of this tonnage came from the southeast extension caving operations and the remainder from Sacramento Hill. The ratio of concentration was 6.33 into 1. The total copper recovery amounted to 86.93 per cent; the sulphide recovery was equivalent to 91.53 per cent. Continued experimental work was carried on during the year to effect raising the ratio of concentration. It met with good success, and equipment has been ordered to give fine grinding in all units of the mill.

Leaching was continued on the portion of the heap first selected, with occasional transfer of irrigation operations to other parts of the heap to allow the necessary time for oxidation. From the beginning of leaching operations up to Jan. 1, 1927, 39.07 per cent of the copper estimated as contained in the portion of the heap being irrigated had been extracted. Percolation of solutions through the heap still continues good, and figures so far obtained are encouraging and exceed the estimates originally made. The precipitation plant operated satisfactorily, with an apparent recovery of 95.56 per cent. The total amount of copper shipped from the plant to the smelter amounted to 1,495,548 lb.

Early in the year the smelter remodeling plans were changed and it was decided, instead of attempting to use part of the old reverberatory plant, to erect a new plant which should consist of two new reverberatory furnaces with superimposed roasters. This entailed an entirely new departure in furnace and roaster practice, but experience showed the new design to be practical and to have possibilities of greatly increased savings. The new plant was pushed through in record time, the first matte being tapped just nine months and four days after the first concrete was poured. The entire job was a creditable one.

Total production of concentrating and direct smelting ores from the Morenci branch and of copper-bearing clean-up material was 1,550,358 dry tons, of which 1,509,068 tons were treated at No. 6 Concentrator.

The mines were in equally good condition at the end of the year as at the end of 1925. An average of 4,826 tons of concentrating ore was mined per working day.

The concentrator producer 129,990 tons of concentrates, which were shipped to the Clifton smelter. The flotation system was remodeled during the year with resultant savings. Satisfactory improvements in this department were made in both metallurgy and costs. The Clifton smelter treated 178,300 tons of new metal-bearing material and produced 64,740,600 lb. of bullion.

Phelps Dodge Production Data

	1926	1925
Company Ores		
Copper, lb	197,849,933	207,175,518
Lead, lb	4,212,054	7,463,908
Silver, oz	1,470,523	1,780,690
Gold, oz	43,756	41,165
Custom Ores		
Copper, lb	2,028,665	1,936,058
Silver, oz	221,708	156,840
Gold, oz	6,520	3,486

The mine production by the Moctezuma Copper Co. amounted to 764,551 tons, compared with 807,113 tons in 1925. The average grade of the ore shipped was much lower.

Metallurgical results and costs at the concentrator were very satisfactory. A complete new installation of flotation machines was completed in December and gives every indication of marked reduction in power consumption and improvement in metallurgy.

Statistical Notes

Burma Mines, Ltd., producing silver and lead in Upper Burma, reports for the quarter ended Dec. 31, 1926, estimated revenue of £755,685. Operating expenditures were £443,565, leaving an estimated surplus of £312,120. Of the ore mined, 70,041 tons went to the concentrator and 4,791 was high grade which went directly to the smelter. The refinery produced 13,618 tons of lead and 1,189,816 oz. of refined silver.

Ohio Copper Co., leaching ores *in situ*, in the Bingham district in Utah, reports for the year 1926 an operating profit of $233,657, and a net profit, after paying taxes, insurance, interest, and other miscellaneous charges, of $140,-261. The following figures detail operations:

Production of copper, lb	4,963,761
Cost per pound, cents	8.9985
Sales price per pound, cents	13.7058

Newmont Mining Corporation, a holding company, reports net profits of $4,113,671 for 1926, compared with $2,141,344 in the preceding year. Among the holdings of the company on Dec. 31, 1926, according to the report, were shares of Texas Gulf Sulphur Co., Kennecott Copper Corporation, Chile Copper Co., Cerro de Pasco Copper

Corporation, Anglo-American Corporation of South Africa, Ltd., Consolidated Main Reef, Ltd., Standard Oil Co. of California, Continental Oil Co., and a comparatively smaller number of shares of other oil companies. The market value of these shares was $28,490,626, based on the last sale prices on exchanges where listed.

Freeport Sulphur Co. has increased its dividend rate from $2 to $4 per share annually. It is believed in Wall Street that the Texas Gulf Sulphur Co., a neighbor of Freeport in the Texas-Louisiana sulphur fields, is expected to increase its present rate of $4 to $5 at the next meeting.

Alaska Juneau Gold Mining Co. reports a loss for the year 1926 amounting to $214,415, compared with $10,835 for the preceding year. These figures are after interest and depreciation but before depletion. The following table compares the results for the last two years:

	1925	1926
Tons mined per day	9,618	10,579
Cost of milling, per ton	$0.2504	$0.2154
Assay value, gold	0.85	0.75
Recovery, gold	0.58	0.50
Total receipts	$2,184,535	$2,067,975
Expenses	2,018,646	2,098,444
Depreciation of plant	176,724	183,947
Loss	214,415	10,835

Isle Royale Mining Co., of Houghton, Mich., reduced tonnage costs in 1926 to $2.39 from $2.62 in 1925, and the cost of copper per pound from 12.14 to 11.46c. before depreciation and depletion charges. Earnings were $1.82 per share, before depletion and depreciation, compared with $1.35 in 1925. Production is at the rate of nearly 1,000,000 lb. per month, total output last year being 11,017,000 lb. Through reasonable selection, yield is kept uniformerly high, it being 24.61 lb. per ton of rock treated last year, compared with 25.22 in 1925. The percentage of discard was only 20.72 against 23.87 the previous year.

Natomas Company of California reports a net loss of $495,483 for the year 1926, after deducting depreciation and depletion, both of which items totaled $325,241. Gold-dredging operations were conducted profitably. Six dredges were operated continuously and dredged 13,786,123 cu.yd., recovering $1,313,921 in gold at an operating cost of $884,452. Operating surplus was $429,469. Gross returns averaged 9.53c. per cubic yard; costs, 6.14c. per cubic yard. The company's rock crushing plants gave only low returns.

American Zinc, Lead & Smelting Co. reports for year ended Dec. 31, 1926, profit, after interest charges, of $473,743, comparing with $498,926 in 1925. After providing for depreciation and depletion reserves amounting to $481,280, there was a deficit of $7,537 against a deficit of $12,241 in the previous year. Current assets on Dec. 31 last were $2,819,666, against $2,722,257 at the end of 1925. Current liabilities amounted to $1,232,766, comparing with $529,550 in previous year.

Petroleum exports from the Maracaibo district of Venezuela, which represent practically the total exports from the entire country, amounted to 33,473,644 barrels in 1926, according to preliminary official figures made public in Venezuela, compared with a total exportation of 19,022,214 barrels in 1925, according to the U. S. Department of Commerce.

Nevada Consolidated Cut Production Costs

Output for Fourth Quarter Highest of the Year

Combined profits of its three units, including the original property in Nevada, the Ray property in Arizona, and the Chino mine in New Mexico, are reported by the Nevada Consolidated Copper Co. as being $2,190,011 for the last quarter of 1926 and $7,791,434 for the entire year. The financial statement for the four quarters is shown in the accompanying table, net income being calculated before allowance for depletion and federal taxes.

	Fourth Quarter	Third Quarter	Second Quarter	First Quarter
Operating profit from copper production	$2,121,354	$1,967,384	$1,711,797	$1,882,956
Value of precious metals	237,133	219,373	212,044	204,880
Miscellaneous revenues, including income from subsidiaries	223,882	244,757	209,050	187,273
Total operating income	$2,582,371	$2,431,515	$2,132,893	$2,275,110
Depreciation	392,359	412,662	412,771	412,662
Net income	$2,190,011	$2,018,853	$1,720,121	$1,862,448

Production of copper in the four quarters starting with the first was as follows: 55,227,970 lb, 55,078,331 lb, 58,180,752 lb, and 62,632,486 lb. The total quantity of company ores milled and smelted during the quarter was 2,865,173 tons. Of this total 2,833,034 tons was concentrating ore, averaging 1.31 per cent copper. The difference of 32,139 tons was shipped direct to smelters. In addition to company ores, 54,740 tons of custom ore was milled or smelted at the Nevada plants. The average daily tonnage of company ores milled at all concentrators was 30,794, as compared to 29,207 tons per day for the preceding quarter.

The average recovery in the form of concentrates from all company material milled during the period was 85.96 per cent of the total copper contained therein, corresponding to 22.48 lb. of copper per ton treated, as compared to a recovery of 86.09 per cent and 22.07 lb. per ton for the previous quarter.

The net cost per pound of copper produced, after crediting revenue from gold and silver and other miscellaneous earnings and income from subsidiaries, was 9.68c., compared with 9.87c. for the third quarter. These costs include all operating and general charges of every kind except depreciation and reserve for federal taxes.

Calumet & Hecla Consolidated Copper Co. reports for 1926, after all charges and credits, but before reserves for depreciation and depletion, net earnings of $4,911,946. This is equivalent to $2.44 a share on the 2,005,502 shares. In 1925 net earnings before reserves amounted to $4,016,844, or $2 a share, and in the year preceding, the first full year of operation as a consolidated entity, profits amounted to only $2,058,752, or $1.02 a share. The items of depreciation and depletion that heretofore have played such an important part in Calumet & Hecla's accounting underwent a sharp revision in the last quarter of 1926. The total charged against earnings on these accounts amounted to only $125,591, against $1,066,430 in the previous quarter. This was occasioned by a credit to depletion on account of adjustments with the government. It brought final depreciation and depletion for the year up to $3,411,628, against $4,453,520 in the preceding year.

San Francisco Mines of Mexico, Ltd., operating in the Parral district in Mexico, during February treated 14,460 tons of ore and 7,850 tons of residues. Production included 2,088 tons of lead concentrates, with an estimated smelter value of $149,471; and 4,025 tons of zinc concentrates, having an estimated value of $114,543. Operating costs were $121,130, leaving a net operating profit of $142,884.

Seneca Copper Mining Co., operating in the Michigan copper country, reports an operating loss of $45,762 for the final quarter of 1926. Copper produced by the company was valued at $171,108.

Shattuck-Denn Mining Corporation shows a profit for 1926 of $51,345 after all expenses, including taxes and interest. The following figures show the principal items of the financial results for the year:

Gross income	$1,153,499
Marketing	1,070,046
Taxes and interest	32,108
Operating profit	$51,345
Depreciation and depletion	87,164
Net loss	$35,819

Interstate Zinc & Lead Co. has issued $1,000,000 in 5-year 7 per cent sinking-fund gold debentures. The funds, it is understood, will be used in financing alterations and improvements as well as new construction. The company was recently organized as a consolidation of the Cherokee Lead & Zinc Co., the Oklahoma Woodchuck Mining Co., the Hutcheon Management Co., and the Meteor Lead & Zinc Co., all of which are engaged in operations in the Tri-State zinc-lead district centering around Joplin. As of Dec. 22, 1926, the properties of the company and its wholly owned subsidiaries had a sound value, as appraised by K. L. Koelker, mining engineer, of $2,858,630. The above appraisal covers only the ore reserves and equipment on 322½ acres. No allowance has been made for any going concern value or for other miscellaneous intangible assets.

The Market Report

Metal Markets Continue Quiet

Silver the Only Metal Selling Higher Than a Week Ago

New York, March 30, 1927—All of the non-ferrous metals have had an uninteresting week, with buyers for the most part keeping under cover and not responding even when producers were willing to shade prices. Demand for copper has been slightly better than last week, but this is all that can be said for it; zinc demand was less, and lead and tin show little change so far as volume of business is concerned.

Copper at 13⅛c.

Copper was generally available for Eastern deliveries at 13¼c. on Thursday, Friday and Saturday, though as early as Friday reports of 13⅛c. seem to be well authenticated. By Monday the market was generally quoted at 13⅛c. and that price has also been the general rule on business placed yesterday and today. The copper sold at 13.05c. was a resale offering. In the Middle West, as low as 13.20c., delivered, has been done. The volume of business has been somewhat greater than last week, but is still much below normal. The total of March sales will be the lowest in months, so the prospect of a good buying wave in the coming week, or possibly in the week after next, seems excellent. Such a wave now seems likely to start at 13⅛c. or 13c. unless the ranks of the sellers show unexpected weakness. The large producers have so far consistently refrained from forcing copper on the market, the depression in price being attributable to the custom smelters who make a policy of selling current intake. Following recent sales, they are perhaps in somewhat improved position. The copper sold has been pretty well distributed over prompt, April, May, and June, all being offered at the same price. Sheet and tube business is reported active, and brass business good, wire continuing to be the dullest line. Copper prices abroad were reduced yesterday by the export association from 13.65 to 13½c., c.i.f.; there, too, the week has been dull.

Lead Prices Decline

A unique situation exists in the lead market. The American Smelting & Refining Co. made two reductions in its official contract price for New York lead: from 7.55c. to 7.45c. per lb. on Friday, March 25, and from 7.45c. to 7.35c. on Tuesday, March 29. After a long, steady decline, the price reached 7.40c. on Jan. 25. This was maintained until March 2, when the price was raised to 7.55c. and the next day to 7.65c. The peculiarity lies in the fact that the present dip has taken the price lower than the bottom reached at the end of the long decline, a condition that has not existed for a good many years. London has declined about £1 in the last ten days, and with buying inactive in the domestic market, the lowering of the price has been logical. The market is quite clearly in the hands of buyers, and sellers are competing for business. In New York, the limited amount of "outside business" has virtually all been at the Smelting company's price. In the Middle West second-hands have been inclined to undersell the principal interests, some lead being available today as low as 7.05c. The absence of buying in volume by battery makers is an important feature in the situation. However, the automobile makers profess to see better times ahead and, with an expansion in their market, battery manufacturers are likely to become more active buyers of lead.

Correction—The New York Metal Exchange advises that an error was made in the cabled price of spot lead in London on Feb. 3. The price published here was 29 7/16, whereas the correct figure was 29 3/16. The corrected average for February is 27.344.

Zinc Close to 6½c.

Demands for zinc from galvanizers have been few and sellers have been obliged to make concessions in price to have their wares at all attractive. The volume of sales has been less than for several weeks. Prompt zinc has been offered for somewhat less than forward; yesterday, for example, early deliveries were available at 6.525c. without being taken up, whereas a good tonnage for forward delivery sold at 6.55c. Today the market is practically the same, though some zinc is reported

Daily Prices of Metals

Mar.	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y.	99 Per Cent	Straits	N. Y.	St. L.	St. L.
24	13.025@13.075	67.75	68.75	7.55	7.25	6.625@6.65
25	13.075	67.50	68.50	7.45	7.20	6.60@6.625
26	13.075	67.00	68.00	7.45	7.15	6.60
28	12.875	66.875	68.00	7.45	7.15	6.55
29	12.90	66.75	68.00	7.325@7.35	7.10	6.525@6.55
30	12.90	67.25	68.75	7.35	7.05	6.525
Av.	12.979	67.188	68.333	7.431	7.150	6.577

Average prices for calendar week ending March 26, 1927, are: Copper, 13.069c.; 99 per cent tin, 67.813c.; Straits, 68.750c.; N. Y. lead, 7.550c.; St. L. lead, 7.258c.; zinc, 6.642c.; and silver, 55.229c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard.

Quotations for copper are for ordinary forms of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per pound is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

March	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
24	55 3/4	56 3/8	62 5/8	312 3/4	297 3/4	27 3/16	27 11/16	30 3/8	30 5/8
25	55 3/4	56 3/8	62 5/8	311 3/4	297 5/8	27 1/4	27 5/8	30 3/16	30 1/2
28	55 1/4	55 7/8	62 1/2	307 1/2	296 5/8	27 1/16	27 9/16	30	30 1/4
29	55	55 5/8	62 1/8	307	296 3/4	26 7/8	27 3/8	29 13/16	30 1/16
30	54 7/8	55 3/8	62 1/4	309 1/4	298 1/2	26 7/8	27 5/16	29 7/8	30 1/16

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Mar.	Sterling Exchange "Checks"	Silver		Gold London	Mar.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
24	4.85	55 1/2	25 5/8	84s11 1/2d	28	4.85 1/8	55 1/2	25 3/4	84s11 1/2d
25	4.85 1/16	55 3/8	25 11/16	84s11 1/2d	29	4.85 1/8	55 5/8	25 3/4	84s11 1/2d
26	4.85 1/8	55 3/8	25 11/16	....	30	4.85 1/8	56 1/4	26 1/16	84s11 1/2d
					Avg.		55.542		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

having been offered as low as 6½c. Some increase in ore production is reported from the Tri-State district, but smelter production is probably curtailed 8 or 10 per cent from a month or so ago. High-grade continues dull at 8½c. delivered in the East.

Tin Quiet and Steady

Tin has been quiet during the week, with prices fluctuating within narrow limits in the domestic market. An advance in London today was reflected in some improvement in the domestic market from a quotational standpoint. Future delivery is at a discount of from 1⅝c. to 2c.; and 99 per cent, for prompt delivery, commands about a cent less than Straits for the same position.

Silver Closes at 56¼c.

Unsettled conditions in China and a moderate demand from India for prompt shipment have been the cause of a steady and gradual rise in silver quotations during the last week. The market appears steady to firm at the close, at 56¼c., the demand being chiefly for near-by deliveries.

Mexican Dollars (old Mexican pesos): March 24th, 41⅞c.; 25th and 26th, 42⅛c.; 28th, 42¼c.; 29th, 42⅜c.; 30th, 42¾c.

Exchanges Steady

Closing cable quotations on the principal foreign exchanges on Tuesday, March 29, were as follows: francs, 3.91⅝c.; lire, 4.59½c.; marks, 23.70½c.; Canadian dollars, ¼ per cent premium.

Other Metals

Quotations cover large wholesale lots unless otherwise specified. London prices are according to latest mail advices.

Aluminum—Per lb., 98 or 99 per cent grade, price of leading interest, 26c.; outside market, 25.30@25.80c. London, 98 per cent, £105@£106 per long ton for domestic consumption.

Antimony—Per lb., duty paid, New York: Chinese brands, spot, nominal, 12½@13.625c.; May arrival at about same level; Cookson's "C" grade, spot, 16⅞c. Market dull. Needle antimony nominally 8c. for lump and 10c. for powdered. White oxide, 16½c.

Bismuth—Per lb., New York, in ton lots, $2.70@$2.75. London, 10s.

Cadmium—Per lb., New York, 60c. London, Australian metal selling freely at 1s. 10d.

Iridium—Per oz., $115@$120 for 98 @99 per cent sponge and powder.

Nickel — Per lb., ingot, 35c.; shot, 36c.; electrolytic, 39c. (99.75 per cent grade). London, £170@£175 per long ton, according to quantity.

Palladium—Per oz., $59@$63. Small lots bring up to $68. Pure metal as a constitutent of crude platinum, $55@ $59 per oz. London, £11@£12, nominal.

Platinum — Official price quoted by the leading interest on miscellaneous orders for refined metal, $108. Open market cash sales of large lots, in New York, $101@$103. Pure metal as a constituent of crude platinum, $100@ $101. Market remains dull.

London, £22 per oz. for refined and £18½@£19½ for crude. Dull.

Quicksilver—Per 75-lb. flask, $116@ $118. Excellent demand in Europe and China. San Francisco wires $107. London, £20½.

The prices of Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of March 5.

Metallic Ores

Manganese Ore—Per long ton unit of Mn, c.i.f. North Atlantic ports, minimum 47 per cent Mn, 36@38c. Caucasian (washed), 53@55 per cent, 38@ 40c. Business dull. Chemical grades unchanged from quotations in the March 5 issue.

Tungsten Ore — Per unit of WO_3, N. Y.: Wolframite, $10.50@$10.75; Western scheelite, $11@$11.25. Dull; prices largely nominal.

Chrome, Iron, Molybdenum, Tantalum, Titanium, Uranium, and Vanadium Ores are unchanged from quotations in the March 5 issue.

Zinc Blende and Lead Ore Prices Lowered

Joplin, Mo., March 26, 1927

Blende	
High	$50.40
Preminum blende, basis 60 per cent zinc	$45.00@ 46.00
Prime Western, basis 60 per cent zinc	44.00
Fines and slimes, 60 per cent zinc	43.00@ 41.00
Average settling price, all zinc	44.65
Galena	
High	$104.70
Basis 80 per cent lead	96.00
Average settling price, all lead	100.96

Shipments for the week: Blende, 14,682; lead, 3,171 tons. Value all ores the week, $975,660.

Shipments for three months: Blende, 166,255; lead, 26,335 tons. Value, all ores three months, $9,878,770.

Compared with a like period of last year there is a decrease of 58,002 tons of blende and 6,744 tons of lead, and the stock in bins is no larger. Producers of zinc concentrate wonder at the discrepancy in demand.

One company sold approximately 2,300 tons of lead last week, and, though the price paid in settlement this week is not made public, there is assurance that the basis price was well over $100 per ton of 80 per cent concentrate. Information of semi-official authority places the price at $101.50 per ton. This week the price was lowered to $96 basis.

Platteville, Wis., March 26, 1927

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$47.75
Lead Ore	
Lead, basis 80 per cent lead	$100.00

Shipments for the week: Blende, 1,250 tons; lead, 40 tons. Shipments for the year: Blende, 16,135; lead, 460 tons. Shipments for the week to separating plants, 1,987 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fullers Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and Zircon are unchanged from prices in the March 5 issue.

Mineral Products

Arsenious Oxide (White Arsenic)—3¾c. per lb. Quiet.

Calcium Molybdate, Copper Sulphate, Sodium Nitrate, Sodium Sulphate (Salt Cake), and Zinc Oxide are unchanged from prices in the March 5 issue.

Ferro-Alloys

Ferromanganese—Domestic and foreign, 78@82 per cent, $100 per long ton, furnace or duty paid, for delivery during first half of 1927. Spiegeleisen, 19@21 per cent, $37@$37.50, f.o.b. furnace; 16@19 per cent, $35; nominal.

Ferrotungsten—$1@$1.05 per lb. of W contained, f.o.b. works. Market spotty.

Ferrocerium, Ferrochrome, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferro-uranium and Ferrovanadium are unchanged from prices in the March 5 issue.

Metal Products

Rolled Copper—Sheets, 22c.; wire, 15½@15⅝c. f.o.b. mill.

Lead Sheets—Full rolled, 11½c. per lb.; clipped, 11½c.

Nickel Silver—29c. per lb. for 18 per cent nickel Grade A sheets.

Yellow (Muntz) Metal—Dimension sheets, 19⅜c. per lb.; rods, 16⅜c.

Zinc Sheets—11c. per lb., f.o.b. mill.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the March 5 issue.

Steel Production Approaching Capacity

Pittsburgh, March 29, 1927

Steel production has been running heavier in the latter part of March than in the fore part, and the month's ingot production may equal that of last March, computed at 92.58 per cent of capacity.

Pig Iron.—Demand continues light. On this account and by reason of merchant furnaces having secured second-quarter coke at lower prices than expected, predictions of an advance in Valley foundry iron, following recent 50c. advances in bessemer and basic, are withdrawn. Bessemer is quoted at $19.50; basic, $18.50; and foundry, $18.50, f.o.b. Valley furnaces.

Connellsville Coke.—After operators had held steadily for $4 to $4.25 on second-quarter furnace coke contracts, there was a sudden break and the bulk of the business has been done at $3.50, with two or three contracts at $3.65@ $3.75. Spot coke remains easy at $3.25 @$3.50 for furnace and $4.50@$5 for foundry.

Mining Stocks—Week Ended March 26, 1927

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	47¼	46⅛	46⅞	Ap.16,May21	Q 0.75
Arcadian Consol.	Boston	*60	*50	*56		
Ariz. Com'l.	Boston	7⅛	6½	6⅝	Ja. 7, Ja. 28	0.50
Calaveras	N. Y. Curb	2⅛	1⅞	2⅛		
Calumet & Arizona	New York	68⅜	66½	67½	Ma. 5, Ma. 21	Q 1.50
Calumet & Hecla	Boston	15⅞	15	15½	Fe.28, Ma.15	Q 0.50
Cerro de Pasco	New York	63	62½	62½	Ja.13,Fe.1, Q	1.00
Chile Copper	New York	39¼	37⅛	37⅜	Ma.4,Apr.1, Q	0.62½
Con. Coppermines	N. Y. Curb	3½	2⅞	3⅛		
Copper Range	Boston	14⅛	13⅛	13⅜	Ap.2, My 2, A	1.00
Crystal Copper	Boston Curb	*28	*26	*27		
East Butte	Boston	2⅛	2⅛	2⅛	Dec., 1919	0.50
Granby Consol.	New York	36½	35½	36	May, 1919	1.25
Greene-Cananea	New York	38⅛	37⅛	37⅜	Nov., 1920	0.50
Hancock	Boston	*60	*50	*60		
Howe Sound	New York	40⅞	39⅜	40	Apr.1,Apr.15	Q 1.00
Inspiration Consl.	New York	19⅛	18⅛	19	Ma.17, Ap.4,Q	0.25
Iron Cap	Boston Curb	1⅛	1⅛	1⅛		
Isle Royale	Boston	10½	9⅜	10⅛	Fe.4, Fe.19 Q	0.50
Kennecott	New York	63⅛	62½	62⅞	Mar. 4 Apr. 1 Q	1.25
Magma Copper	New York	35⅛	34⅜	35⅛	Ma.31,Ap.15,Q	0.75
Mason Valley	N. Y. Curb	1⅞	1⅞	1⅞		
Miami Copper	New York	16	13⅜	15⅛	Fe.1, Fe.15 Q	0.37½
Mohawk	Boston	40	39	39	Ja.29, Ma.1 Q	1.00
Mother Lode Coa.	New York	4½	4	4½	De.10, De.31SA	0.37½
Nevada Consol.	New York	14⅛	14¼	14⅜	Ma.17,Ma.31Q	0.37½
New Cornelia	Boston	23	21⅞	21⅞	Fe.4, Fe.21 Q	0.50
Noranda	N. Y. Curb	24	20½	20⅝		
North Butte	Boston	2	1 1/16	1 1/16	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*48	*42	*45	Sept., 1926	0.03
Old Dominion	Boston	14	12⅞	14	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	127	127	127	Ma.22, Apr.2	Q 1.50
Quincy	Boston	17⅞	17	17⅛	Mar., 1920	1.00
Ray Consolidated	New York	15⅞	14⅞	15⅞	Ap.20, Ap.30	0.25
St. Mary's Min. Ld.	Boston	23	23	23	Fe.10 Ma.10	2.00
Seneca Copper	New York	2⅝	2½	2½		
Shattuck-Denn	Boston Curb	5	4½	4⅝		
Tenn. C. & C.	New York	11⅞	11⅛	11⅛	Fe.28, Ma.15, Q	0.25
United Verde Ex.	N. Y. Curb	26	25⅛	25⅜	Apr.6, May1 Q	0.75
Utah Copper	New York	112	112	112	Ma.17,Ma.31Q	1.50
Utah Metal & T.	Boston	1⅛	1 1/16	1 1/16	Dec., 1917	0.30
Walker Mining	Salt Lake	*70	*67	*70		
NICKEL-COPPER						
Internat. Nickel	New York	40¾	39½	39⅞	Ma.17,Ma.31Q	0.50
Internat. Nickel, pfd.	New York	106	106	106	Ja. 13, Fe.1, Q	1.50
LEAD						
Gladstone Mtn.	Spokane	*29	*29	*29	March, 1927	0.005
National Lead	New York	196	191⅜	193	Ma.11,Ma.31Q	2.00
National Lead pfd.	New York	130	128	128⅜	March, 1927 Q	1.75
St. Joseph Lead	New York	41⅞	40⅛	41⅜	Jn.10,Jn 20, Q	X0.75
ZINC						
Am. Z. L. & S.	New York	9⅛	8⅜	8⅜	May, 1917	1.00
Am. Z. L. & S, pfd.	New York	49	47	48	Nov., 1920	1.50
Butte C. & Z	New York	3⅜	3⅜	3⅜	De.9, De.24	0.50
Butte & Superior	New York	10	9⅛	9⅛	Ma.15, Ma.31Q	0.50
Callahan Zn-Ld	New York	1⅞	1⅜	1⅜	Dec., 1920	0.50
Consol. Lead&Zinc'A'	St. Louis	....	....	16	Ma.15, Ap.1 Q	0.25
Eagle-Picher	Cincinnati	27⅞	27⅛	27⅜	Fe.15, Ma.1 Q	0.40
Eagle-Picher, pfd.	Cincinnati	....	....	100	De.31, Ja.15 Q	1.50
New Jersey Zn.	N. Y. Curb	190⅛	188⅛	190⅛	Ja.20, Fe.10 Q	2.00
United Zinc	N. Y. Curb	....	....	55		
Yellow Pine	Los Angeles	*25	*20	*25	Dec. 1925	Q 0.04
GOLD						
Alaska Juneau	New York	1⅞	1⅛	1⅞		
Argonaut	Toronto	*41½	*35	*38		
Barry-Hollinger	Toronto	*42	*40	*42		
Carson Hill	Boston	....	....	*11		
Consol. W. Dome L.	Toronto	*9	*6½	*9		
Cresson Consol. G.	N. Y. Curb	2 7/16	2¼	2⅜	Ma.31,Ap.10	Q 0.10
Dome Mines	New York	8¼	8⅛	8⅛	De.31,Ja.30,0	Q 0.50
Golden Cycle	N. Y. Curb	....	....	1⅜	Fe.28,Ma.10	Q 0.04
Hollinger Consol.	Toronto	21.20	20.85	21.00	Ma.9, Ma.25	0.10
Homestake Mining	New York	62	62	62	Ma.19,Ma.25	M 0.50
Kirkland Lake	Toronto	*89	*85	*85		
Lake Shore	Toronto	18.15	17.95	18.00	Ma.1, Ma.15	0.10
McIntyre-Porcupine	New York	25⅜	24⅞	24⅞	Fe.1, Ma.1 Q	0.25
Portland	Colo Springs	†*52	†*50	..	Ap.6, Ap.15, Q	0.02
Rand Mines	New York	....	....	9⅛	Au.23-30Am.Sh.	1.52
Teck-Hughes	Toronto	6.44	6.25	6.40	Ja.31, Fe. 1	0.05
Tom Reed	Los Angeles	*42½	*40	*40	Dec., 1926	0.02
Tough-Oakes	Toronto	*47½	*39	*45		
United Eastern	N. Y. Curb	*45	*45	*45	July, 1924	0.05
Vipond Cons.	Toronto	1.49	1.45	1.47	Apr.1 Apr.15	0.03
Wright-Hargreaves	Toronto	11.09	10.50	10.55	Ap.15,My.2	0.10
GOLD AND SILVER						
Carnegie Metals	Pittsburgh	....	....	12⅜		
Con. Cortez	N. Y. Curb	*25	*19	*20		
Con. Virginia	San Francisco	*3½	*2⅜	*2⅜		
Dolores Esperanza	N. Y. Curb	*35	*35	35	July, 1923	0.05
Premier Gold	N. Y. Curb	2 1/16	2	2 1/16	Ma.15, Ap.4Q	0.08
Tonopah Belmont	N. Y. Curb	....	....	2 1/16	Ma.15, Ap.4	0.08
Tonopah Extension	N. Y. Curb	....	....	28	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	....	....	3⅜	Ma.31, Apr.21	0.07½
West End Consol.	N. Y. Curb	*15	*14	*14	Mar., 1923	0.05
Yukon Gold	N. Y. Curb	...	...	*45	June, 1918	0.02
SILVER						
Beaver Consol.	Toronto	*63½	*61	*62	May. 1926	0.03
Canadian Lorrain.	Toronto	*40	*35	*36		
Castle-Trethewey	Toronto	1.00	*95	*97		
Coniagas	Toronto	3.71	3.55	3.55	May, 1924	0.12½
Keeley	Toronto	1.42	1.39	1.41	Fe 28, Ma.15	X 0.12
Lorrain Trout Lake	Toronto	....	....	*35	July, 1925	0.05
McKinley-Dar.-Sav	Toronto	*13¾	*13	*13½	Oct., 1920	0.03

Stock	Exch	High	Low	Last		Last Div.
SILVER—(Continued)						
Mining Corp. Can.	Toronto	3.15	3.05	3.14	De.30, Ja.15	0.12½
Nipissing	N. Y. Curb	8⅛	*7⅞	*7⅞	Ma.31, Ap.20	Q 0.15
SILVER-LEAD						
Ahumada	New York	4¾	4⅞	4⅞	Ma 25,Ap 4,Q	X 0.12½
Bingham Mines	Boston	43	42	42	Ma.21, Ap.5 Q	1.00
Bunker Hill&Sullivan	N. Y. Curb	75	74	74	March, 1927	M 0.75
Cardiff M. & M.	Salt Lake	*38	*38	*38	Feb. 5, 1927	0.10
Chief Consol.	Salt Lake	....	....	2.60	Oc.10, No.1 Q	0.10
Consti'n Mng.&Mill'g	Spokane	*36	*30	*36		
Erupcion	Boston Curb	*80	*75	*75	Ma.25, Ap.2 Q	0.07½
Eureka Lily	Salt Lake	1.47½	1.37½	1.37½		
Federal M. & S.	New York	115	105	108		
Federal M. & S., pfd.	New York	93½	90	92	Fe.24, Ma.15 Q	1.75
Hawthorne Mines	N. Y. Curb	*5	*3	*5		
Hecla Mining	N. Y. Curb	14¾	14⅛	14⅜	Fe.15,Ma.15 Q	0.25
Highland-Surprise	Spokane	*13	*10	*10		
Iron King Mining	Salt Lake	*42	*35	*37		
Keystone Mining	Salt Lake	*36	*36	*36	Au.12, Au.26	0.07½
Lucky Jim	Spokane	*18½	*17½	*18½		
Lucky Tiger-Com.	Kansas City	†7.15	†7.00	....	Ma 20, 1927	M 0.05
Mammoth Mining	Salt Lake	2.00	2.00	2.00	De.17, Fe.23,Q	0.25
Marsh Mines	Spokane	2⅛	2⅛	2⅛		
North Lily	Salt Lake	3.55	3.00	3.05		
Park Utah	New York	7⅛	7⅛	7⅛	Ma 15, Ap 1	Q 0.20
Plutus Mining	Salt Lake	....	....	1.95	Ja.10, J .15	Q 0.10
San Rafael	San Francisco	....	....	*25		
Silver King Coal.	Salt Lake	7.80	7.60	7.60	Ma.21, Ap.1	Q 0.25
Silversmith	Spokane	*32	*30	*30	Oc.1, Oc 10	Q 0.02
Strattons Mines	Spokane	*44½	*43	*44		
Sunshine M. Co.	Spokane	*52	*50	*51		
Tamarack-Custer	Spokane	*29½	*27½	*28	Sept., 1924	0.25
Tintic Standard	Salt Lake	11.00	10.87½	11.00	Ma.16, Ma.29	X 0.40
Utah-Apex	Boston	6⅛	6⅛	6⅛	Oct. 1926,	0.25
IRON						
Bethlehem Steel	New York	51½	48⅞	51	July, 1924	1.25
Butler Bros.	Chicago	23½	22⅞	23½	Ja. 29, Fe. 15	Q 0.625
Cleveland-Cliffs Iron	Cleveland	..	....	75	Ja.15, Ja.25	Q 1.00
Colorado Fuel & Iron	New York	59⅞	56⅝	58⅛	May, 1921	0.75
Gt. North'n Iron Ore	New York	21⅜	21	21	Dec.6, Dec.28	0.75
Inland Steel	New York	42⅜	42	42⅜	Fe 15, Ma.1	Q 0.62½
Replogle Steel	New York	11⅛	10⅛	11⅛		
Republic I. & S.	New York	73⅛	69⅛	70⅞	Fe.15 Ma. 1	Q 1.0
Republic I. & S. pfd.	New York	103¾	103⅛	103⅛	Ma 15, Ap.1	Q 1.75
Sloss-Sheffield S. & I.	New York	129½	123⅜	129⅓	Ma 10, Ma.21	Q 1.50
Sloss-Shef. S.&I. pfd.	New York	104½	104⅛	104⅓	Ma 21, Ap.1	Q 1.75
U. S. Steel	New York	119⅜	117⅛	119⅞	Fe 28,Ma 30	Q 1.75
U. S. Steel pfd	New York	130⅜	129⅞	130⅜	Ja 29, Fe.26,	Q 1.75
Virginia I. C. & C.	New York	...	...	44	Jan., 1924	1.50
Virginia I.C.&C.pfd.	New York	...	...	60⅛	De.15, Ja.2,	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol	New York	...	...	30⅛	Ja.26, Ja.29	1.45
So. Am. Gold & P.	N. Y. Curb	3⅞	3½	3½		
Alum.Co.of Amer.	N.Y.Curb	71½	69½	69½		
Alum. Co. of Amerpf.	N.Y.Curb	102½	102	102½	Ma.15,Ap.1	Q 1.50
Vanadium Corp.	New York	50½	45	50	Fe.1, Fe.15,	Q 0.75
Patino M. & E.	New York	23⅜	20	22	Ma.10, Ma.15	4 sh.
ASBESTOS						
Asbestos Corp.	Montreal	22⅛	20⅜	21	Jan., 1926	1.50
Asbestos Corp., pfd.	Montreal	90½	84½	85½	Ma.31,Ap.15	Q 1.75
SULPHUR						
Freeport Texas	New York	57½	52½	55⅞	Ma.2, Ap.15	Q 1.00
Texas Gulf, new	New York	63	58½	62	Ma.1, Ma.15	Q 1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	43¾	42⅛	43⅜	Fe.18, Ma.1	Q 0.75
Amer. Metal pfd.	New York	....	....	110⅜	Fe.19, Ma.1	Q 1.75
Amer. Sm. & Ref.	New York	147⅞	142	145⅞	Ja.14, Fe.1,	Q 2.00
Amer. Sm.&Ref.pfd.	New York	121¼	120	121⅛	Fe.4, Ma.1,	Q 1.75
Consol. M. & S.	Montreal	259	248	258	De.31, Ja.15	X 6.25
Federated Metals	N. Y. Curb	13½	13½	13½		
Newmont Mining	N. Y. Curb	75	73¼	74	Ma.31,Ap.15	Q 0.60
U. S. Sm. R. & M.	New York	42	38⅞	40	Ja.6, Ja.15,	Q 0.87½
U. S. Sm. R.&M.pfd.	New York	48½	48¼	48⅓	Ja.6, Ja.15,	Q 0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED MARCH 15, 1927

Name	High	Low	Last		Last Div. Date	Amount
Aramayo Mines (25 frs.)	85 —	80/7½	82/6	Feb.	1927	5 (†)
British Platinum (£1)	4/7½	3 6	4 —	Feb.	1925	2½ p.c.
Burma Corpn. (10 rupees)	14/7½	13 3	14/4½	Feb.	1927	6 annas*
Bwana M'Kubwa (5s)	6/7½	6/4½	6/7½			
Camp Bird (2s)	5/9¼	3/3	5/3			
El Oro (£1)	4/10½	4/—	4 9	Nov.	1924	2½ p.c.*
Esperanza (10s)	—/2	—/2	— 2			
Frontino & Bolivia (£1)	16/3	11/10½	12 6	Jan.	1927	5 p.c.
Mexican Corpn. (£1)	10/1½	8 6	9 9			
Mexico Mines of El Oro (£1)	18/9	15/7½	18 9	Dec.	1926	3¾ p.c.*
N'Changa Copper Mining	15/—	12/6	13/9			
Oroville Dredging (£1)	6/6	5/—	6 4½	Dec.	1923	3½ p.c.
Ouro Preto (£1)	2/1½	2/—	2/—	May	1925	2½ p.c.
Rhodesian Congo Border (£1)	67/3	64 4½	65 —			
St. John del Rey (£1)	14/—	12 10½	13 6	May	1927	3¾ p.c.
San Francisco Mines (10s)	31/3	30 6	30/9	Jan.	1927	25s.
Santa Gertrudis (£1)	16/—	15/3	15/6	Jan.	1927	3¾ p.c.
Selukwe (2s. 6d.)	10/9	9/10½	10/3	April	1917	6¾ p.c.
S. Amer. Copper (2s.)	3/4½	3/1½	3/3	Nov.	1917	75 p.c.
Tanganyika (£1)	55/6	48/—	50/—	Aug.	1926	7½ p.c.
Tomboy (£1)	3/6	3/—	3/3	July	1926	10 p.c.
Union Miniere du Haut-Katanga (Brussels)	8.990	8.700	8.990	July	1926	175 (‡)

* Free of British income tax. † Swiss frs. ‡ Belgian frs. and free of taxation.